AGRICULTURAL DEVELOPMENT AND FOOD SECURITY IN NORTH BIHAR PLAIN

ABSTRACT

THESIS

SUBMITTED FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy

IN

GEOGRAPHY

BY

RIFAT ZAHRA

UNDER THE SUPERVISION OF

DR. S. NAUSHAD AHMAD

(Reader)

DEPARTMENT OF GEOGRAPHY
ALIGARH MUSLIM UNIVERSITY
ALIGARH (INDIA)

2007

ABSTRACT

Although, food is one of the basic human needs and it is indispensable for survival of life, millions of people all over the world do not have enough to eat and are suffering from the problems of under nutrition and malnutrition. Roughly, 800 million people remain seriously malnourished including 240 million children in the world. The daily diet of these chronically hungry people lacks an average intake shortage of 100-400 kilo calories diminishing their ability to lead an active life. Out of the total malnourished/undernourished people of the world, nearly 87 percent of them are found in developing countries and remaining 13 per cent in the developed world. Thus, the problem of hunger is more severe in the poor developing countries because hunger and poverty both are cause and effect of each other.

Hunger and starvation have adverse effects on human health and efficiency. Hunger causes illness and death, robs people of their potentials to work and cripples children's learning capacity and growth as normal adults. It traps individuals in a vicious cycle of poor health that passes from one generation to the next. The damage caused by chronic undernourishment begins at early age and follows people throughout life.

Thus, hunger not only cuts short the lives of individuals but also damages the peace and prosperity of the nations. As the human development itself gets impaired the country faces a staggering loss in terms of productivity, disease and disability. As an off shoot of chronic hunger the nation faces enhanced conflict and social unrest often accompanied by blatant misuse of fragile natural resources.

Over a period of fifty years, the Indian agriculture made a spectacular progress in raising production and the country achieved food security at national level. Now India is the leading producer of vegetables and fruits in addition to cereals and food products. This ensures availability of foodgrains of 181 kg. per capita per annum. However, the country has not achieved food security at regional, household and individual levels. It is a paradoxical situation that there is sufficient food production in the country capable of

feeding its entire population, still a large proportion of the Indian population goes hungry to bed without two square meals a day in different parts of the country in varying proportions. The main reasons of chronic food insecurity in the country appears to be had lack of purchasing power, poverty, unemployment and in-access to productive resources. India is still home to the largest number of poor in the world with nearly 26 per cent of its total population living below poverty line. It accounts for one fifth of the world's poor (260 millions).

Since, nineties average annual growth of food grains in India for example has been 1.73 per cent compared to annual average population growth of 1.85 percent leading to a problem of food crises in future.

Thus, achieving food security will be the greatest challenge for the country in the new millennium owing to declining trend of food grain production in last decade and projected to further drop. The food demand is projected to grow at 4 to 5 per cent for milk products, fruits, vegetables, sugar and raw sugar, 3 to 4 per cent for edible oils and pulses, 2.0 to 2.2 per cent for cereals –2.2 during 2000-10 and 2.0 during 2010-20.

In the background of above facts the present study assumes immense significance in the North Bihar Plain which is one of the backward regions of India where late adoption of modern agricultural inputs and lack of employment in secondary and tertiary sectors of economy has caused low purchasing power among sizable population living in rural areas.

The North Bihar Plain has a predominantly rural and agrarian economy. About 92.71 per cent population of the region lives in rural areas and 80 per cent of this depends on agriculture. The total population of region is 54.17 million with a growth rate of 2.8 per cent per annum. The density of population in the region is 1005 persons per square km, whereas, the state as a whole has a density of 880 persons per square km. Per capita land availability (0.073 hectare) is very low due to greater pressure of population per household. . This has led to fragmentation of holding and the average size of land holding is very small (92 per cent land holdings are below 2 hectares).Majority of the people have to depend on the land resources for their livelihood. Total cultivated area of the region is 40.08 million hectares and the total foodgrains production is 7.08 million tones in 2001. The percentage

of main workers to the total population is about 25.34 against the all India average of about 37.5. The literacy rate in the region is about 38 per cent, which is less than the all India rate of 52.2 per cent. A little less than half of the total population (45 per cent) is found below poverty line or is either underfed or malnourished. This area with very high density and immense poverty has been labeled as rural slum.

The objectives of the present study are to examine the physical and socio-economic profiles of the study area which provide the basic framework for evaluating the situation of agriculture and food availability, to study the institutional and technological factors determining agricultural development, to measure the regional pattern of the levels of agricultural productivity as an important indicator of agricultural development and food security, to identify the indicators of food security and examine the inter-district variations in food availability, stability, accessibility and overall food security, to establish relationships among the indicators of agricultural development and food security, to assess the impact of agricultural development on food security and in the last to suggest remedial measures for reducing food insecurity in the region.

The present study is based on secondary data collected from various sources such as Annual Season and Crop Report, Bihar Through Figures and Official Records of Directorate of Statistics and Evaluation, Government of Bihar, Patna. Data related to Population and Social attributes have been taken from Census publications .District has been taken as the unit of analysis. In Vorder to analyze and measure level of agricultural development and food security twenty one variables relating to agricultural development and food security have been taken for the year 2000-2001. Selection of suitable indicators is of immense significance for any study because it constitutes the crux of methodology and with the help of it, pertinent research questions are asked. Only those indicators have been chosen which are relevant to the nature of problem and are available at different points of time.

The techniques of Yang's yield index and Z-score have been used for the analysis of present work. The indices of crop productivity have been calculated on the basis of Yang's Yield Index method, whereas, the levels of

agricultural development and the levels of food security have been measured with the help of composite Z-score statistical technique.

For examining the impact of agriculture on food security, the statistical technique of regression equation Y= a+ bx and Scatter diagram has been used. To find out correlation between agricultural development and food security, Pearson's correlation method has also been used. Tables and Figures have been prepared on the basis of calculation of data collected from various sources.

The hypotheses of the present study are North Bihar Plain is one of the backward regions of India, where marked regional disparities exist in terms of food security, the agricultural development of the region to a larger extent depends on the use of modern inputs as well as institutional factors, food security in the study area is positively co-related with its agricultural development, food insecurity is reduced with increase in agricultural development, because agriculture provides food and employment to the largest section of population in the study area.

The present study entitled 'Agricultural Development and Food Security in North Bihar Plain' is divided into six chapters excluding introduction and conclusion. Chapter first deals with a brief discussion of physical environment and socio-economic profiles in the study area. Chapter second examines the concept of food security and changes in its nature. Chapter third is devoted to analysis of determinants of agricultural development which includes the inputs like spatial patterns of irrigation, HYV of seeds, chemical fertilizes, use of agricultural machineries, credit facilities etc. Agricultural development, which is one of the important factors of food security, has been discussed in Chapter fourth. In this chapter agricultural development both in terms of input as well as output indicators has been analyzed. Chapter fifth deals with districtwise distribution of food security in terms of food availability, stability and accessibility and overall food security. Relationships among various indicators of agricultural development and food security have been examined in chapter sixth.

Lastly, the study has been concluded highlighting its main findings and suggestions have been made for overcoming the problems of food insecurity especially in food insecure regions.

The study reveals that there are marked regional variations in the levels of agricultural development, its determinants and food security in the North Bihar Plain. The levels of overall agricultural development measured in terms of a large number of input and output indicators is either high or medium in the western and southern parts of the study area, whereas, its eastern and northern parts is very backward in this regard. This pattern is also in close conformity with distributional pattern of the factors of agricultural development.

It has been observed in the present study that yield of cereals in North Bihar Plain is remarkably lower than the national average which shows that it is one of the agriculturally backward regions of India. It is mainly due to the fact that there is lack of irrigation facility without which success of other inputs are less effective.

The study further also reveals that caloric availability of the study area is far below 1944 calories per person per day than the national average of 2365 in 2001. It means that the study area has not been able to fulfill the total requirement of caloric intake of its people even at national standard level i.e., 2400 calories per person per day. The distributional pattern of caloric availability during 2001 among the districts of North Bihar Plain is not uniform as it varies from 1394 calories per head per day in Madhubani district to 3200 calories in West Champaran.

The position of foodgrains availability which is an important indicator of food security has also not been reported satisfactory during 2001. It has been estimated that 8.43 million tones of foodgrains have been required to meet minimum requirement of the existing population but actual production is 7.08 million tones. Thus, there is shortage of food up to the tune of 1.35 million tones. The regional average in respect of the availability of food has been worked out to 131 kg. per head per annum and the national average being 173 kg. as against a minimum requirement of 176 kg. This clearly implies an overall deficit in the supply of foodgrains to the extent of 45 kg. per capita per annum in the case of North Bihar Plain .

The regional pattern of food availability clearly shows that food deficit districts are mostly confined in the central part of the study area. The position in this regard is better in western and eastern part of the study area which either record high or moderate foodgrains availability. By and large similar pattern in the case of food stability and accessibility have also been observed. The overall situation of food security is better in the western and south eastern part of the study region, whereas it

is worst in north central districts except only one isolated district in south central part. As far as relationship between food security and agricultural development is concerned, it is found to be moderately positive in the case of roughly 41 per cent of the districts.

AGRICULTURAL DEVELOPMENT AND FOOD SECURITY IN NORTH BIHAR PLAIN

THESIS

SUBMITTED FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy

IN

GEOGRAPHY

BY

RIFAT ZAHRA

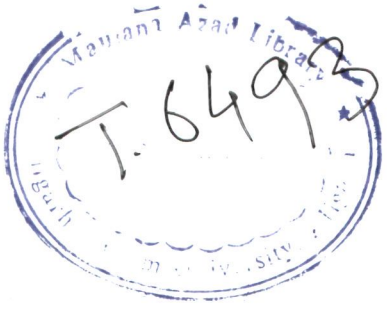
UNDER THE SUPERVISION OF

DR. S. NAUSHAD AHMAD

(Reader)

DEPARTMENT OF GEOGRAPHY
ALIGARH MUSLIM UNIVERSITY
ALIGARH (INDIA)

2007



Dr. Syed Naushad Ahmad
(Reader)

Phone: Office (0571) 2700683
DEPARTMENT OF GEOGRAPHY
ALIGARH MUSLIM UNIVERSITY
ALIGARH-20200

Date: 28.4.2007

Certificate

This is to certify that ***Miss Rifat Zahra*** *has completed her Ph.D. thesis entitled "**Agricultural Development and Food Security in North Bihar Plain**" under my supervision. In my opinion it is fit for submission and evaluation.*

(Dr. Syed Naushad Ahmad)
Supervisor

Dedicated

to

My Loving Parents

and

Sisters

ACKNOWLEDGEMENTS

*I express my sincere and deep sense of gratitude to my supervisor , **Dr. Syed Naushad Ahmad** , Reader , Department of Geography , A.M.U , Aligarh , under whose indispensable guidance and kind supervision , this work was carried out .I am sincerely thankful to **Prof. Abdul Munir** , chairman , Department of Geography A.M.U. ,Aligarh who provided all the necessary facilities during the course of my work.*

*I am also thankful to **Prof.Emeritus Mohd Shafi, Prof. Ali Mohammad, Prof. Hifzur Rahman** and **Prof. Farasat Ali Siddiqui,** Department of Geography, A.M.U., Aligarh for their help in solving some of the methodological problems during my research.*

*Thanks are also due to **Dr. Yasir Hanafi, Dr. Nurruzzaman, Mustaqeem , Mohd. Asif, Abdul Bari, Kaneez Zaman and Rukhsana for** their co-operation and moral support .I wish to extend heartiest thanks to my hostelmates **Lubna Mustafa**, **Sarita Priyadarshini** and **Shaheda Kausar.***

*My thanks are also to **Mrs.Talat Kaneez Fatima,** and **Mr. Najmuddin** seminar incharge, cartographer **Mr. Javed Ahmad**, Department of Geography A.M.U., Aligarh for their generous help at all stages in completion of my thesis. I wish to express my thanks to all staff member of the library, all the members of the Directorate of Statistics and Evaluation, Bihar, Patna. I am also thankful to **Mr.Abul Kalam Azad** for his cooperation in computer typing.*

*Finally, I wish to express my gratitude and sincere regards to my **parents** for their intrinsic support and encouragement throughout my research work. It gives me immense pleasure to thanks to my sisters **Iffat Zahra, Ismat Zahra** and brother- in - law **Mr.Iqbal Qasim** who have always been a source of inspiration for me for higher academic pursuits.*

*Above all I express my gratitude to **Almighty ALLAH** who provided and guided all the channels to work in cohesion and coordination and led me to this path of success.*

Date ***Rifat Zahra***

CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Statement of the Problem

Although, food is one of the basic human needs and it is indispensable for survival of life, millions of people all over the world do not have enough to eat and are suffering from the problems of under nutrition and malnutrition. Roughly, 800 million people remain seriously malnourished including 240 million children in the world. The daily diet of these chronically hungry people lacks an average intake shortage of 100-400 kilo calories diminishing their ability to lead an active life (Sarkar, 2001).[1] Out of the total malnourished/undernourished people of the world, nearly 87 percent of them are found in developing countries and remaining 13 per cent in the developed world. Thus, the problem of hunger is more severe in the poor developing countries because hunger and poverty both are cause and effect of each other.

Hunger and starvation have adverse effects on human health and efficiency. Hunger causes illness and death, robs people of their potentials to work and cripples children's learning capacity and growth as normal adults. It traps individuals in a vicious cycle of poor health that passes from one generation to the next. The damage caused by chronic undernourishment begins at early age and follows people throughout life. Deprived of sufficient calories and nutrients, the body compensates to reducing physical activities. In children growth slows or virtually stops with disastrous consequences. A hungry mother gives birth to an underweight baby who then faces a future plagued by stunted growth and frequent illness.

Thus, hunger not only cuts short the lives of individuals but also damages the peace and prosperity of the nations. As the human development itself gets impaired the country faces a staggering loss in terms of productivity, disease and disability. As an off shoot of chronic hunger the nation faces enhanced conflict and social unrest often accompanied by blatant misuse of fragile natural resources (Ghosh, 2000).[2] Realizing the significance of the access of adequate nutritious food by all individuals throughout the year, Food and Agriculture Organization (FAO) emphasized the need of attaining food security at all levels in the world. The World Food Conference

(1974)[3] convened in Rome by FAO/Untied Nations reaffirmed that every man, women and child has the inalienable right to be free from hunger and malnutrition in order to develop fully and maintain their physical and mental faculties.

The World Bank has estimated that 15 millions people were below poverty line and out of them 630 millions suffered from extreme poverty. It further stated that 80 per cent of the world's poor live in rural areas where bulk of people earn their living from farming but the status of farming on the whole is not encouraging. Recently, Food and Agricultural Organization (FAO) assessment indicates that world agricultural productivity including both crops and livestock is going down. In comparison to 1980s the growth rate of food grains output in 1990s was almost half i.e. 1.8 per cent as against 3.45 per cent (Mohammad, 2003).[4]

Over a period of fifty years, the Indian agriculture made a spectacular progress in raising production and the country achieved food security at national level. The green revolution enabled the country to increase food grain production from 50.82 million tones in 1950-51 to 208.87 million tones in 1999-2000. Similarly, White Revolution made India as number one milk producing country in the world (57 million tones). The Blue Revolution also made sufficient increase in marine and fresh water fish production. Now India is the leading producer of vegetables and fruits in addition to cereals and food products. This ensures availability of food grains of 181 kg. per capita per annum. However, the country has not achieved food security at regional, household and individual levels (Swaminathan, 2001, [5] and Gopalan, 2002).[6] It is a paradoxical situation that there is sufficient food production in the country capable of feeding its entire population, still a large proportion of the Indian population goes hungry to bed without two square meals a day in different parts of the country in varying proportions. The main reasons of chronic food insecurity in the country appears to be had lack of purchasing power, poverty, unemployment and in-access to productive resources. India is still home to the largest number of poor in the world with nearly 26 per cent of its total population living below poverty line. It accounts for one fifth of the world's poor (260 millions). Nearly, half of the children suffer from malnutrition (47.7 per cent in 2000-01) and half of the adult population

suffers from chronic energy deficiency (Radhakrinsha, 2002).[7] The nutritional status of women in India is also very poor. Since, mothers are malnourished and anemic, one third of new born babies are of low weight (Gopi, 2001).[8]

Since, nineties average annual growth of food grains in India for example has been 1.73 per cent compared to annual average population growth of 1.85 percent leading to a problem of food crises in future (Ghosh, 2000).[9]

Thus, achieving food security will be the greatest challenge for the country in the new millennium owing to declining trend of food grain production in last decade and projected to further drop (Hedge, 2000).[10] The food demand is projected to grow at 4 to 5 per cent for milk products, fruits, vegetables, sugar and raw sugar, 3 to 4 per cent for edible oils and pulses, 2.0 to 2.2 per cent for cereals –2.2 during 2000-10 and 2.0 during 2010-20 (Radhakrishna, 2002).[11]

In the background of above facts the present study assumes immense significance in the North Bihar Plain which is one of the backward regions of India where late adoption of modern agricultural inputs and lack of employment in secondary and tertiary sectors of economy has caused low purchasing power among sizable population living in rural areas.

The North Bihar Plain has a predominantly rural and agrarian economy. About 92.71 per cent population of the region lives in rural areas and 80 per cent of this depends on agriculture. The total population of region is 54.17 million with a growth rate of 2.8 per cent per annum. The density of population in the region is 1005 persons per square km, whereas, the state as a whole has a density of 880 persons per square km. (The Census of India, 2001).[12] Per capita land availability (0.073 hectare) is very low due to greater pressure of population per household. . This has led to fragmentation of holding and the average size of land holding is very small (92 per cent land holdings are below 2 hectares).Majority of the people have to depend on the land resources for their livelihood. Total cultivated area of the region is 40.08 million hectares and the total foodgrains production is 7.08 million tones in 2001. The percentage of main workers to the total population is about 25.34 against the all India average of about 37.5. The literacy rate in the region is about 38 per cent, which is less than the all India rate of 52.2 per cent. A little

less than half of the total population (45 per cent) is found below poverty line or is either underfed or malnourished. This area with very high density and immense poverty has been labeled as rural slum (Krishan, 1979).[13]

Objective of the Study

1. To examine the physical and socio-economic profiles of the study area which provide the basic framework for evaluating the situation of agriculture and food availability.
2. To study the institutional and technological factors determining agricultural development.
3. To measure the regional pattern of the levels of agricultural productivity as an important indicator of agricultural development and food security.
4. To identify the indicators of food security and examine the inter-district variations in food availability, stability, accessibility and overall food security.
5. To establish relationships among the indicators of agricultural development and food security.
6. To assess the impact of agricultural development on food security.
7. To suggest remedial measures for reducing food insecurity in the region.

Database and Methodology

The present study is based on secondary data collected from various sources such as Annual Season and Crop Report, Bihar Through Figures and Official Records of Directorate of Statistics and Evaluation, Government of Bihar, Patna. Data related to Population and Social attributes have been taken from census publications .District has been taken as the unit of analysis. In order to analyze and measure level of agricultural development and food security twenty one variables relating to agricultural development and food security have been taken for the year 2000-2001. Selection of suitable indicators is of immense significance for any study because it constitutes the crux of methodology and with the help of it, pertinent research questions are

asked. Only those indicators have been chosen which are relevant to the nature of problem and are available at different points of time.

The techniques of Yang's yield index and Z-score have been used for the analysis of present work. The indices of crop productivity have been calculated on the basis of Yang's Yield Index method, whereas, the levels of agricultural development and the levels of food security have been measured with the help of composite Z-score statistical technique.

For examining the impact of agriculture on food security, the statistical technique of regression equation $Y = a + bx$ and Scatter diagram has been used. To find out correlation between agricultural development and food security, Pearson's correlation method has also been used. Tables and Figures have been prepared on the basis of calculation of data collected from various sources.

Hypotheses

1) North Bihar Plain is one of the backward regions of India, where marked regional disparities exist in terms of food security.
2) The agricultural development of the region to a larger extent depends on the use of modern inputs as well as institutional factors.
3) Food security in the study area is positively co-related with its agricultural development.
4) Food insecurity is reduced with increase in agricultural development, because agriculture provides food and employment to the largest section of population in the study area.

Organization of the study

The present study entitled 'Agricultural Development and Food Security in North Bihar Plain' is divided into six chapters excluding introduction and conclusion. Chapter first deals with a brief discussion of physical environment and socio-economic profiles in the study area. Chapter second examines the concept of food security and changes in its nature. Chapter third is devoted to analysis of determinants of agricultural development which includes the inputs like spatial patterns of irrigation, HYV of seeds, chemical fertilizes, use of agricultural machineries, credit facilities

etc. Agricultural development, which is one of the important factors of food security, has been discussed in Chapter fourth. In this chapter agricultural development both in terms of input as well as output indicators has been analyzed. Chapter fifth deals with districtwise distribution of food security in terms of food availability, stability and accessibility and overall food security. Relationships among various indicators of agricultural development and food security have been examined in chapter sixth.

Lastly, the study has been concluded highlighting its main findings and suggestions have been made for overcoming the problems of food insecurity especially in food insecure regions.

Review Work Done So Far

It is rather difficult to review the vast literature existing on Food security and its various related aspects. However, a modest attempt has been made in this regard. In Indian context; the issue of food security is poorly understood and analyzed focusing mainly on the spatial distribution of food availability but two other important components of food security i.e. food stability and accessibility have been ignored. One thing very important to note is that very iittle work has been done on household food security in India at micro level.

Though, India has achieved self-sufficiency in food production and enough food is available at national level, still hunger and malnutrition persist at regional, household and even at individual levels. Therefore, future research on food security should be directed towards regional, household and individual levels. Food insecure household and individuals which mostly belong to weaker sections of society including scheduled castes and tribes, other backward castes, marginal income groups, women's and children etc. should be identified and remedial measures should be taken.

Sinha (1961)[14] examined the trends in demand and supply of food in India over a period of two decades (1940-60) and he stated that the production of food remained more or less deficient in the country. An important work was done by Aykroyd (1966)[15] on nutritive value of Indian foods which was revised by Gopalan (1966). It is considered as a masterpiece for onward research on the food and nutrition. He examined in his study the nutritive

values of food items in India and also recommended the balance diets for Indian population according to their work, age and sex. Gopalan and Raghawan (1969)[16] prepared 'Nutrition Atlas of India' showing nutritional status of Indian population in different states. Food and Agricultural Organization (1956)[17] presented an account in its reports regarding the scope and limitations of world food reserve. Dick Morris (1978)[18] briefly evaluated the major work of FAO/UN relating to food security between 1969 and 1976. FAO/UN (1969) emphasized the agricultural policies for meeting demand growth of food in the world arena. In 1973 FAO focused on role of tariffs and trade in achieving world food security. The World Food Conference held in 1974 emphasized the need to take the initiatives for National and International Programmes for attaining food security in the developing countries. The World Food Conference of 1974 was mainly concerned with global food security and it was realized that world food crisis was a common responsibility of all nations. FAO (1975) stressed on International reserve of food stock for emergencies and also focused on national food grains stock policies in third world countries regarding the world food security. World Food Council (1976) examined the role of food reserve and food aid at the time of emergencies in the context of world food security. It also examined the International system of food security and further analyzed the International food reserve for developing countries.

United States Department of Agriculture (1977)[19] discussed the relationship between trade and food security. Food and Agricultural Organization and World Food Programme (1979)[20] examined the food aid requirements and food aid target in the eighties and gave stress on the need for Balance Of Payment (BOP) support to meet exceptional variation in food import bills. Mitra and Mukherji (1980)[21] studied the relationship between population growth and food supply in India in terms of change in demand and availability of food with change in population and also measured the caloric requirement of population according to sex and age. They divided India into food surplus and deficit regions at district level. Calleur and Blandford (1981)[22] analyzed the role of the International wheat agreements in relation to food security. Swaminathan (1981)[23] stressed on need of building a national food security system. Clay and Longhurst (1981)[24] analyzed the food imports,

food aid and food security in East and South Africa. FAO (1981)[25] analyzed the problems of food security in the face of crises. International Monetary Fund (1981)[26] explained the compensatory financing for fluctuations in the cost of cereal imports.

Bigman (1982)[27] analyzed the system of food security and price stabilization. FAO (1982a) [28] highlighted the special arrangement for food security assistance to developing countries and gave a detailed account of activities of food security assistance schemes. FAO (1982b) [29] also analyzed the sub-regional and regional food security schemes and their objectives.

Acharya (1983)[30] examined the conceptual framework and historical background of food security in India. He focused on buffer stocks, distribution system and its management. Singh (1984)[31] pointed out that the use of irrigation, HYV of seeds and chemical fertilizers cannot increase agricultural productivity, unless the farmers are educated for the judicious use of these inputs.

Shafi and Aziz (1989)[32] highlighted that the structure of food system from production to the consumption stage has certain interrelations among all activities connected with food production, storage, transport, processing, marketing, distribution, consumption and all other related activities. They further suggested that it is extremely important to pay attention to minimize the food losses.

Siddiqui and Naqvi (1989)[33] discussed the public distribution system of food grains in India. They pointed out that reducing disparities and feeding an impoverished society is an uphill task, which can be achieved through public distribution system provided there is improvement in income of people, generation of employment and check on leakages of food under public distribution system.

Singh (1989)[34] suggested a marketing system with a network of all weathered rural roads linking the farms to the central village and the central village to the rural town. Das (1989)[35] discussed the availability of food grains and food policy in a backward region of North Bihar Plain. He pointed out that there might be good prospects for achieving self sufficiency, if there was a change in state policy related to change in the agrarian structure.

Sharma (1989)[36] discussed the problem of food supply in Rajasthan and after considering the general food situation in the state, suggested a shift in emphasis from cereals to protective food stuffs. Shafi (1989)[37] explained how losses in food grains storage should be minimized through rural godowns and scientific storage at the farm level among the small and marginal farmers. Imam (1989)[38] discussed the changing cropping pattern and its impact on nutrition in a district of Bihar. Mishra (1989)[39] emphasized the need of fighting hunger through poverty alleviation programmes by the government.

Mohammad (1989)[40] analyzed the food production and food problem in India. He attempted a state level analysis of trends in area, production, yield of food grain crops, supply and demand for food grains, food availability, surplus and deficit situations in the country and suggested various strategies of achieving food security. Mohammad (1995)[41] also examined the problems of food availability and security in the Middle- East.

Dev (1996)[42] analyzed the importance of Public Distribution System (PDS) Vs. Employment Generation Programmes (EGP) in attainment food security with special reference to poor section of the society in India.

Suryanarayana (1997)[43] in his article entitled Uruguay Round and Global Food Security discussed the salient features of the Uruguay Round GATT and its implications for global food security. He argued the targeted efforts in ensuring food security at the regional as well as household levels in backward regions of Asia and Africa. He further pointed out that in India expenditure on food dominates household budget, where, nearly 64 per cent of total expenditure in rural areas and 56 per cent of urban area is devoted to food, hence, food security should be the major focus of policy concern with the welfare, particularly of the poor.

The most important work in the field of food security was edited by Chaturvedi (1997)[44] entitled 'Food Security and Panchayati Raj System in India' in which many scholars contributed their articles on food security at household levels and their solution through the Panchayati Raj System in India. Banerjee (1997)[45] examined the population explosion, food security and sustainable development.

Hanafi (1999)[46] in his study also examined the declining trend of food availability and food security in Uttar Pradesh. He observed that the state as a

whole was self-sufficient in food production but there were a number of districts deficient in food grain availability. He also suggested various measures to overcome this problem.

Vyas (2000)[47] examined the role of state, market and civil society in the field of food security. Bhagat (2000)[48] examined the population growth, poverty and food grains supply in India and also pointed out the trends and future prospect. Hegde (2000)[49] explained the role of NGO's in securing food security. He assessed various developmental programmes, under 'Food for work' such developmental works including conservation of natural resources and improvement of agricultural productivity, which can help the local community to gain confidence and manage their resources for sustainable livelihood.

Singh (2000)[50] suggested that India may get rid of hunger and poverty if concurrent attention is paid to improve food availability through ecologically sustainable methods of production and revitalizing the earlier tradition of cultivating a wide range of food crops.

Swaminathan (2001)[51] suggested achieving sustainable livelihood and freedom from hunger through 'Community Grain Bank' which should be established at village level, where there is acute problems of hunger. Swaminathan (2001)[52] in his study concluded that despite satisfactory progress in food production widespread food insecurity prevails at household level and observed that poverty is the main cause of household food insecurity and further stated that availability may not be a problem if there is adequate consumption capacity. He suggested that new agriculture should aim to produce not only more food but also more livelihood opportunities in the farm and non-farm sectors. Sarkar (2001)[53] analyzed the problems of national food security perspective with a global vision.

Singh (2002)[54] suggested that the poor will have to be protected not through price control of agricultural commodities alone but through a proper income policy as well. The best way is to initiate Employment Generation Programmes in building labours intensive rural infrastructure.

Venkataramani (2002)[55] pointed out that the agricultural development in the country should be put on a faster track to meet the food grains demand of the future.

Radhakrishna (2002)[56] concluded in his study on food and nutrition in India that though India achieved some success in combating transitory food insecurity caused by drought or floods, it failed to make much dent in the chronic food insecurity which is reflected in low energy intake and high incidence of malnutrition. The improvement in malnutrition was very slow.

Vyas (2003)[57] discussed the economic policies needed for improving availability of food, household entitlement to access it and stability in its supply. He suggested that the key factors in raising productivity are the level of public investment in agriculture, strengthening of supportive institutions of credit and marketing and accessibility of productivity enhancing technology.

Jha and Srinivasan (2003)[58] discussed the importance of targeted PDS in reducing hunger and malnutrition among weaker section of society and how the benefit cost ratio would increase where subsidies are targeted at the poor.

Alagh (2003)[59] attempted to develop an integrated information and decision support system to achieve the objectives of food security and hunger removal, as part of a diversification strategy consistent with the new trade regime.

Indrakant and Hari Krishan (2003)[60] examined the food security situation in Andhra Pradesh which was found in the category of food grains surplus and food secure at the macro level but food insecure at the household level. About one fourth of the states population suffered from chronic food insecurity and nearly 40 per cent of the children were victim of malnutrition.

Mohammad (2003)[61] analyzed spatial inequality in food security in rural India. His study was based on demand and supply indicators in the absence of required data of import and export of various agriculture produce at district level for nation as a whole. He analyzed regional patterns of food security in terms of kilocalories and monetary value.

Joshi and Gulati (2004)[62] studied the status of agricultural diversification in South Asian countries and concluded that the diversification of agriculture was in favour of more competitive and high value commodities. He suggested that, diversification can be used as a tool to augment farm income, generate employment, alleviate poverty and conserve precious soil and water resources.

REFERENCES

1. Sarkar, A. N. (2001): National Food Security Perspective with a Global Vision, *Indian Farming,* Vol. 50, No. 10, p. 30.
2. Ghosh, G.N. (2000): Food Insecurity, The greatest challenge of the Millennium, *Indian Farming,* Vol. 50, No. 7, p. 7.
3. FAO (1974): The World Food Conference in 1974, United Nations.
4. Mohammad, N. (2003): Spatial Inequality in Food Security in Rural India, *The Geographer,* Vol. 50, No.1, p. 44.
5. Swaminathan, M.S. (2001): Science and Sustainable Food Security, *Indian Farming,* Vol. 50, No. 10, p. 5.
6. Gopalan, S. (2002): *Food Security or Crises in Food Security* in South Asia, Chaturvedi, P.(ed.) Concept Publishing Company, New Delhi. p. 101.
7. Radhakrishna, R. (2002): Food and Nutrition Security in Parikh K.S. and Radhakrishna, R. (ed.) *India Development Report*, Oxford University Press, p. 51.
8. Gopi. N.G (2001): Fight hunger to reduce poverty: An international scenario, *Indian Farming,* Vol.50, No.10, p.67.
9. Ghosh,G.N.(2000) Food Insecurity, The Greatest Challenge of the Millennium, *Indian Farming*, Vol. 50, No. 7, p. 8.
10. Hedge, N.G. (2000): Challenges of Food Insecurity- Call for a Paradigm Shift, *Indian Farming*, Vol. 50, No. 7, p. 18.
11. Radhakrishna, R. (2002): Food and Nutrition Security in Parikh K.S. and Radhakrishna, R. (ed.) *India Development Report*, Oxford University Press, pp.51-52.
12. The Census of India (2001).
13. Krishan, G. (1979): Non Agriculture Workers in India in Rural India, Population Geography, Vol. 1, No. 1&2 , p. 20.
14. Sinha, R.P. (1961): Food in India, Oxford University Press.
15. Aykroyd, W. R. et al (1966), The Nutritive value of Indian Foods and the Planning of Satisfactory Diets, ICMR, New Delhi, p.30.
16. Gopalan, C. and Raghavan (1969): The Nutrition Atlas of India, National Institute of Nutrition, Indian ICMR, Hyderabad.

17. FAO (1956): Functions of a World Food Reserve – Scope and Limitations. FAO Commodity Policy Studies No. 10, Rome.

18. Dick Morris (1978): FOOD PRODUCTION SYSTEMS, 14 National Priorities 15 International relationships. The Open University, Technology: A Second Level Course. Unit 14.

19. United States Department of Agriculture (1977): The Relationship between Trade and World Food Security Dale Hathaway Washington, D.C.

20. FAO and WFP (1979): Food Aid Requirements and Food Aid Targets in the Eighties in Collaboration with World Food Programme. (WFP & CFA: 8/4-A), Rome.

21. Mitra, A. and Mukerje, S. (1980): Population Food and Land Inequality in India 1971, Geography of Hunger and Insecurity, New Delhi.

22. Calleur, D.L. & Blandford, C. (1981): Food Security and the International wheat Agreements. Cornell Agricultural Economics Staff Paper, Department of Agricultural Economics, Cornell University.

23. Swaminathan, M.S. (1981): Building a National Food Security System, Indian Environmental Society, New Delhi.

24. Clay, E.J. & Longhurst, R. (1981): Food Security, Food Imports and Food Aid in East and Southern Africa, Institute of Development Studies, Sussex.

25. FAO (1981): Food Security in the Face of Crises. E. Saouma, Ceres, Vol. 14, No.2 Rome.

26. International Monetary Fund (1981): Compensatory Financing for Fluctuations in the Cost of Cereal Imports. Louis Goreur, in Food Security for Developing Countries, Secretariat Paper, No. 13 London.

27. Bigman, D. (1982): Coping with Hunger: Towards a System of Food Security and Price Stabilization,. Cambridge, Massachusetts.

28. FAO (1982a): Review of Special Arrangement for Food Security Assistance to Developing Countries – Activities of Food Security Assistance Scheme. (CFS: 82/7 Sup.).

29. FAO (1982b): Sub-Regional and Regional Food Security Schemes Aimed at Strengthening the Collective Self-Reliance of Developing Countries (CFS: 82/4) Rome.

30. Acharya, K.C.S. (1983): Food Security System of India, Concept Publishing. Company, New Delhi.

31. Singh, R.P. (1984): Plant protection- A must, Yojna, Vol. 28, No. 11, p.27.

32. Shafi, M. and Aziz, A. (1989): Food System of the World. Rawat Pubication, Jaipur.

33. Siddiqui, I. and Naqvi, Z. (1989): *Public Distribution*, Ibid, pp. 266-286.

34. Singh, A. (1989): *Tenuity of Rural Transport in Food Marketing in Aligarh District, Uttar Pradesh*, Ibid, pp. 287-296.

35. Das, K.K.L. (1989): *Availability of Foodgrains and Food Policy in a Backward Region of North Bihar Plain*, Ibid, pp. 506-517.

36. Sharma K. P. (1989): *Population and Food Supply in Rajasthan*, op.cit., pp 463-466.

37. Shafi, M. (ed.) (1989): *Minimizing the Lossess in Foodgrains in Storage: An Aspect of Post-Harvest Technology,* ibid, pp. 262-265.

38. Imam, E. (1989): *Changing Cropping Pattern and Nutrition in District Siwan, Bihar*, ibid, pp. 243-249

39. Mishra, K.K. (1989): *Technological Innovations and their impact on Food Productivity in a Backward Region: A case study of Hamirpur District*, ibid, pp. 134-143.

40. Mohammad, A. (1989): Food Production and Food Problem in India, Concept Pubication, New Delhi.

41. Mohammad, A. (1995): Problem of Food Availability and Security in the Middle East, *The Geographer*, Vol. 52, No. 2, pp. 59–71.

42. Dev, S.M. (1996): Food Security: PDS Vs EGS A Tale of Two States, *Economic and Political Weekly*, Vol. 31, No. 27, pp. 1752–64.

43. Suryanarayana, M.H. (1997): Uruguay Round and Global Food Security, *Economic and Political Weekly*, Vol. XXXII, No. 43, pp 2821-2828.

44. Chaturvedi R. (1997): Food Security and Panchayati Raj. Concept Publication, New Delhi.

45. Banerjee, B. (1997): Population Explosion, Food Security and Sustainable Development, *Geographical Review of India*, Vol. 59, No. 1, pp. 1-10.

46. Hanafi, et al, (1999): Declining Trend of Food grains Availability and Food Security in U.P., *The Geographer* ,Vol. 46, No. 2 pp. 137-54.

47. Vyas, V.S. (2000): Ensuring Food Security, The State, Market and Civil Society, *Economic and Political weekly*, Vol. 35, No. 50, pp. 1402-07.

48. Bhagat, R. B. (2000): Population Growth, Poverty and Food Grains Supply in India :The Present Trend and Future Prospects, *Asian Profile*, Vol.23, pp.309-18

49. Hedge, N.G. (2000): Challenges, of Food Insecurity-Call for a Paradigm Shift, *Indian Farming*, Vol. 50, No. 7, pp. 18-21.

50. Singh, T.P. (2000): Green Revolution, Food Security and Agricultural Sustainability in India: The Conflicts and Solutions, *Asian Profile*, Vol. 28, No. 6, Dec. pp. 487-497.

51. Swaminathan,M.S. (2001): Sustainable Livelihood and Freedom from Hunger, *Indian Farming*, Vol.51, No.8, pp.6-9.

52. Swaminathan,M.S. (2001):Science and Sustainable Food Security, *Indian Farming*, Vol.50,No.10,p.4

53. Sarkar, A.N. (2001): National Food Security Perspectives with a Global Vision, *Indian Economy*, Vol. 50, No. 10, pp. 29-36.

54. Singh P. (2002): Realizing an Agricultural Dream, *The Hindu, Survey of Indian Agriculture*, pp. 15-22.

55. Venkataranami, G. (2002): Policies need to be Farmer Friendly, Ibid, pp. 5-8.

56. RadhaKrishna, R.,(2002): Food and Nutrition Security in Parikh , S., and Radha Krishna , R. (eds) *Indian Development Report*, Oxford University Press, p.51

57. Vijay S.Vyas, (2003): *Economic Policies for Ensuring Food Security* (ed.) Dev and et.al., Towards a Food Secure India , Published By Institute For Human Development, New Delhi, pp .113-13

58. Jha, S. and Srinivasan, P.V. (2003): On Improving the Effectiveness of the PDS in Achieving Food Security, ibid, pp. 365-387.

59. Alagh, Y.K. (2003): *Newer Paradigms of Food Security,* Towards A Food Secure India, Published by Institute for Human Developments, New Delhi, pp. 113-131.

60. Indrakant and Harikrishan (2003): *Food Security in Andhra Pradesh in Retrospect* and Prospect ibid, pp. 170-185.

61. Mohammad, N. (2003): Spatial inequality in Food Security in Rural India, *The Geographer*, Vol. 50, No.1, pp. 43-57.

62. Joshi, P.K. Gulati, A., Birthal, P.S., Tewari, L (2004): Agriculture Diversification in South Asia: patterns, Determinants and Policity Implications. *Economic and Political Weekly*, Vol. XXXIX, No. 24, pp. 2457-2467, July 12-18, 2004.

Chapter I

PHYSICAL AND SOCIO-ECONOMIC PROFILE OF THE STUDY AREA

LOCATION

The study region (North Bihar Plain) is located wholly to the north of the river Ganga except the district of Bhagalpur, some portion of which extends to the south of the river Ganga. It is lying in the fertile agricultural area of Tarai region. The latitudinal extent of this region is between 24° 31'N and 27° 25' N and the meridians of 83° 51' E and 88°15'E. The total geographical area of the region is 55, 01,513 square kms. occupying nearly, 30 per cent of the total area of Bihar and is bordered on the north by Nepal and on the south by the river Ganga. On the west it is bounded by the districts of Deoria and Ballia of the state of Uttar Pradesh and on the east by the district of Darjeeling of the state of West Bengal. At present there are 22 districts (Fig.1.1).

STRUCTURE AND RELIEF

The North Bihar Plain is geographically a part of the Indo-Gangetic plain which lies between the Gondwanaland of Peninsular India in the south and the recently built young fold mountain chains of the Himalayas in the north. It was formed as a result of deposition of sediments or detritus in the depression brought by the great Himalayan rivers.

There are differences of opinion among the geologists as regards the origin and nature of the depression. Edward Sues an Australian geologist (1956), holds the view that it was a 'foredeep' fronting the Himalayan earth waves a "sagging" or subsidence of northern part of the Peninsula as it arrested the southward movement of the mountain waves (Wadia, 1939).[1] The foredeep was gradually filled in by the eroded material from the Himalayas and Gondwana shield and this led to the formation of the plain.

Burrard (1912)[2], on the basis of geological data and geodetic observations suggested quite different view. He holds the view, that the north

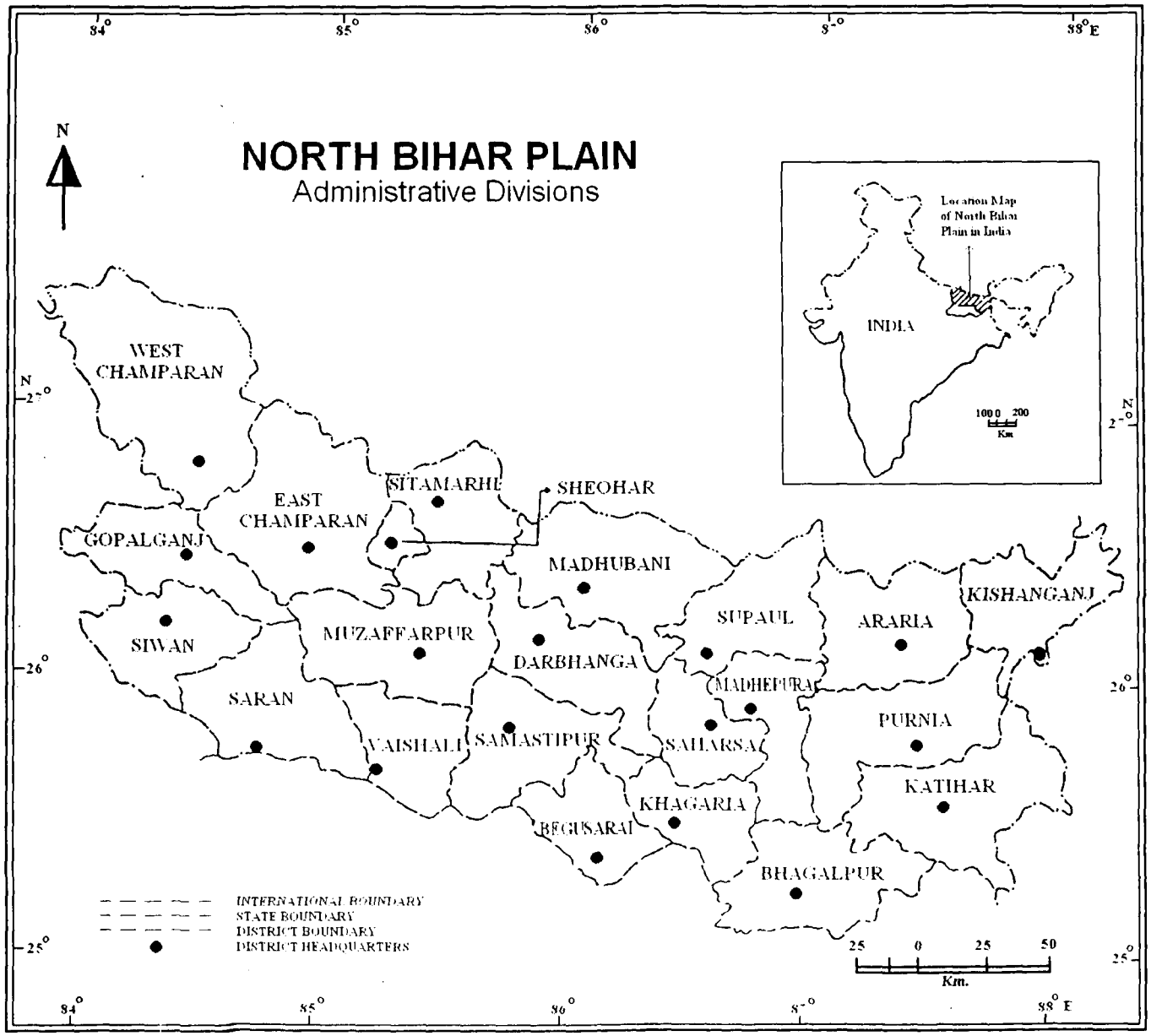

NORTH BIHAR PLAIN
Administrative Divisions
N
Location Map of North Bihar Plain in India
INDIA
1000 0 200
Km
WEST CHAMPARAN
EAST CHAMPARAN
SITAMARHI
SHEOHAR
GOPALGANJ
MADHUBANI
SIWAN
MUZAFFARPUR
DARBHANGA
SUPAUL
ARARIA
KISHANGANJ
SARAN
VAISHALI
SAMASTIPUR
MADHEPURA
SAHARSA
PURNIA
KATIHAR
KHAGARIA
BEGUSARAI
BHAGALPUR
INTERNATIONAL BOUNDARY
STATE BOUNDARY
DISTRICT BOUNDARY
DISTRICT HEADQUARTERS
25 0 25 50
Km.
84°
85°
86°
87°
88° E
27° N
26°
25°

Fig.1.1

Indian plain represents a rift-valley bounded by parallel faults on either side with a maximum down throw of 32 kms.

A third and more recent view regarding the origin of this region is that it is a sag in the crust formed between the northward drifting of Indian continent and the comparatively soft sediments accumulated in the Tethyan basin when the later were crumpled and lifted up into a mountain system (Krishnan, 1956)[3]. The depression perhaps began to form in the upper Eocene and attained its greatest development during the third Himalayan upheaval in middle-Miocene. Since, then it was gradually filled up by sediments to form a level plain with a very gentle seaward slope (Krishanan, 1956)[4]. On the basis of geological and geodetic evidences several contradictory estimates of the depth of this depression are made. Oldham (1917)[5], finds the depth of Gangetic trough to be 4.6 to 7.0 km at its northern edge. Cowle (1921)[6], while criticizing the above findings postulated even higher figures from the same data. However, the estimation has made it clear that the deepest part is near to the northern edge than the southern. It becomes shallower towards the peninsular margin.

The North Bihar Plain, as it forms part of North Indian plains, comprises the alluvial deposits of clay, silt and sand with occasional beds of gravel, calcareous nodules and peaty organic matter. Geologically, these deposits may be classified into two broad categories: the *'bangar'* or the older alluvium and the newer alluvium commonly known as *'khadar.* The *bangar* corresponds to the deposits of Pleistocene age of the geological history, while the *khadar* belongs to the recent age. A clear distinction between these two alluviums is made on the basis of fossils found in them with respective to ages. The *bangar* contains the remains of extinct species of animals including Rhinoceros, Hippopotamus, Palaeolaxoden, Elephas and Equus. The fossils in the newer alluvium are mostly those of animals still living (Krishnan, 1956)[7].

The entire tract of the North Bihar Plain is monotonously a flat plain without a single hill appearing above it. The only diversities seen are due to river action, a series of river side uplands are found which, are known as levees. The general direction of the slope of the plain is from northwest to southeast towards the Ganga, but it is gentler in the west than in the east.

North Bihar Plain is traversed by a series of southward flowing rivers namely, the Ghaghara, the Gandak, the Burhi Gandak, the Kamla and the Kosi, and their tributaries. The Himalayan streams originating mainly in the outer Himalaya deposit a huge load in the shape of alluvial fans at the foothills of mountain due to the sudden change in the gradient which becomes gentle. These rivers namely, the Kosi and the Gandak generally erode their beds and banks and remove the older alluvium from the higher northern tracts and deposit it further down streams in the southern section. The deposits are laid down in the southern part because of the greater flatness and low lying nature of the region. Forced by new deposits, the streams have developed a tendency to change their courses very often. Sometimes, they cut across the meanders and splits off in a number of channels, so that there is not only the tendency of redistributing the alluvium within their beds and banks, but rather the alluvium seems to be spread far beyond the river banks, over a greater part of the surrounding country during the floods. Flooding of these rivers is, thus, a characteristic feature of the southern part of North Bihar Plain.

North Bihar Plain may be divided into five distinct physiographic units: I. The Western Bangar Plain, II. The Burhi Gandak-Baghmati Doab, III. The Submontane Bangar Tract , IV. The Kosi Flood Plain and V. The Ganga Riverine Strip.

I. The Western Bangar Plain

It lies to the north of river Ganga and spreads upto river Burhi Gandak and covers the entire area of Gopalganj, Siwan and Saran districts, southern part of East Champaran district, southern half of Muzaffarpur and west central part of Samastipur district. The plain has a slightly higher elevation than the adjacent areas and has a level surface. It slopes gradually from northwest corner of Gopalganj, which has an elevation of 68 meters above sea level towards southeast where the elevation is 30 meters in the Begusarai district. This plain is cut by major streams draining through the area. The uniformity of this level plain is also broken here and there by the depression and marshes that dot the entire area. These depressions are specially found in the southeastern part of Muzaffarpur district where there are small

small'Chauras'(semi circular and marshly lowlands) or tals (natural depression filled with water during rain).

II. The Burhi Gandak-Baghmati Doab

It is a narrow but considerably long belt of khadar land running in a northwest to southeast direction from Motihari in the East Champaran district to the confluence of rivers Kosi and Ganga near Karhagala in Katihar district. It is a lowland area with an average elevation of 29 meters above sea-level, the lowest in the whole of North Bihar Plain. It consists of 'khadar' land traversed by the rivers Burhi Gandak, Baghmati and Kosi. These rivers passing through this region are relatively narrow in their upper parts but open out and become broad in their lower courses. The Burhi Gandak-Baghmati Doab land of Central Champaran, Muzaffarpur and Darbhanga is more or less level and forms a distinct low land section studded with innumerable long semi circular lake formed due to the shifting course of river Burhi Gandak. This low land, section is subjected to inundations during rains. The Doab extends further eastwards to include Rosera-Bahera lowland in Darbhanga and Kabor tal depression of North Munger district. Eastward from Khagaria subdivision upto Naughachia subdivision of Bhagalpur, it may be called the Ganga-Kosi Doab because it is occupied mainly by the present channel of river Kosi.

III. The Sub-Montane Bangar Tract

An elongated belt of entirely different structure from the remaining part of North Bihar Plain runs parallel to the foothills from Sumeshwar and the Dun ranges in the west to Purnia district in the east. It is an elevated tract formed of bangar (older alluvial) deposits. There are, however, some low lying areas near the streams and marshes that are conspicuous amongst the high lying elevated areas.

IV. The Kosi Flood Plain

In between the Baghmati rivers in the west and the Mahananda river in the east excluding the Mahananda upland in the northwestern and Mahananda lowland in south Purnia district, the entire area is an extensive low lying plain intersected by numerous streams and marshes. It is a region, which is liable to

floods from rivers traversing the area. The rivers are interconnected by numerous deep and wide channels called 'Dhars'. The only elevated land of the area is formed by the levees of the larger rivers from which the land gradually slopes outwards often meeting a similar sloping surface from some other river. The interfuvial plains are usually studded with numerous marshes, which frequently have great areal extent. The whole of this eastern section, as a matter of fact, can be regarded as the flood plain of the Kosi. The river Kosi and other Himalayan streams that drain this part have large independent river basins or catchments areas. It is worthwhile to note that this river does not make deposits of silt like the Ganga, but on the contrary brings enormous amount of course sand which is spread over the fields making them infertile. Sometimes the amount of detritus and sand is so great that the beds are raised above the surrounding land. The Kosi has been responsible for enormous devastation by flood or by spreads of micaceous sand (O'malley, 1911)[8].The Kosi flood plain is thus a 'Sandy flat' full of dead channels of river Kosi. In the vast expanse of the sandy deposits there develop pastures of fine grasses. These prairie-like plains are called 'Ramnas' that support a sizeable number of cattle and sheep. The newly formed 'Chauras' or alluvial deposits are covered with dense jungles and course grass, forming a good cover for wild animals (Report of The Irrigation Commission, 1972)[9].

V. The Ganga Riverine Strip

It is a narrow strip of lowland about 3 to 16 kilometers wide extending along both the sides of the main bed of the river Ganga. It is a low plain where the Ganga takes an intricate meandering course and often makes sharp bends leaving at place semi circular channels called 'Chara' or 'Oxbow' lakes. The braided pattern of the streams and shifting of the channels are the main characteristics and the region is subjected to great variation with respect to width and aggradations at one end and degradations at the other. Wherever the banks are high, they present an effective barrier against the degradational action of streams. Several such high banks occur close to the Ganga standing at natural levees and these afford good riparian sites for human settlements. One such high bank runs from Chapra to Dighwara and Pahlezaghat in Saran district. The other important banks are from Mungerghat to Khagaria district

and in the east along Kursela and Monihari ghat in Purnia district. These high lands are as a matter of fact, always liable to be cut away and the lowlands which lie behind these natural levees or high banks are regularly inundated every year by the river Ganga floods which find there way through the drainage openings in its banks and while spreading over the inland country fill the large 'Chauras' or marshes which are so prominent feature behind these high banks in Saran and Munger district. Where the banks are sloping, the riverbeds setup an eddy in the current, which become sufficiently stationary to deposit a portion of the sand, which holds in solution. The level of the ' Diara' which is so far nothing but a heap of sand, then gradually rises as the water lying stagnant spreads a thin layer of clay and silt over the sand, and this deposit of silt increases at every high flood until the 'Diara' rises above flood level. The soil of Diara land is very fertile and grows good crops.

DRAINAGE

The general directions of slope of the land in North Bihar Plain is from northwest to southeast and all the rivers rising in the Himalaya flow in this direction and ultimately join the river Ganga. The important rivers of this tract draining into the river Ganga are the Ghaghra and its tributaries, Jhorahi and the Daha, Gandak, the Burhi Gandak with its tributary Baghmati, Kosi and its tributary Kamla and the Mahananda (Fig 1.2).

The Ghaghara

The river Ghaghara also known as the Sarju is a mighty river commanding a large catchments area in the Himalayas. The little Gandak near about 3 Kilometers to the south of village Gothiri joins it on its left bank where it forms the boundary between Bihar and Uttar Pradesh. Later on, after receiving the Thorahi and the Daha, two small rivers on its left, the river finally joins the river Ganga a few Kilometers downstream from Chapra. The course of the river Ghaghara is liable to great fluctuations. It has an average gradient of 21 cms. per kilometers in this region. The banks in many places are high but, like the river Ganga, it inundates the countryside by forcing its

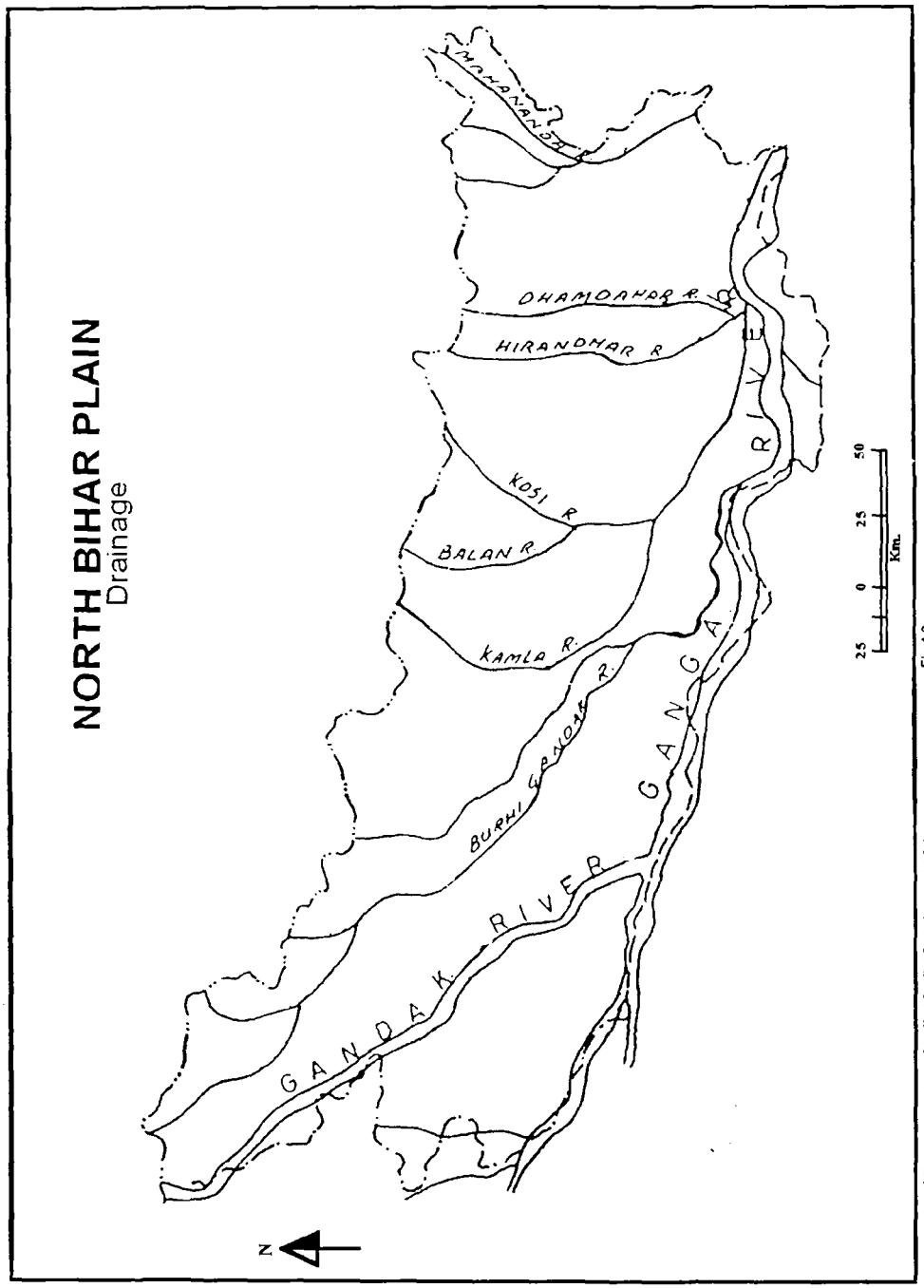


Fig.1.2

Source: Land Resource Atlas of India,NATMO,Calcutta,1996.

way up the small tributary rivers commands a drainage basin of 3,000 square kilometers in Bihar.

The Gandak

River Gandak is also known as the Saligrams in Nepal and Narayani or Kali in Indian plain. The northeastern part of Dhaulgiri in Tibet at 29^{0}18" North and 83°58' East longitude is the main source of the river. It flows across the districts of West Champaran, East Champaran, Gopalganj, Saran, Vaishali and Muzaffarpur for about 250 kilometers in the Indian Plains and drains a total area of about 7, 620 square kilometers. It joins the river Ganga at Sonpur. Its banks are generally higher than the adjacent land, a fact that has had considerable influence on the people living in Saran district as the floods often overflow the banks and inundate large tracts of land. It has no tributaries all through its course in the plains. The length of the Gandak is 630 kilometers. The Gandak project has recently been constructed at Tribeni and it irrigates about 1.47 million hectares of land in North Bihar Plain, Utter Pradesh and Nepal (Ahmad, 1946-47)[10]. The command area of the project in North Bihar Plain accounts for about 9.53 lakh hectares, which includes the districts of West Champaran, East Champaran, Gopalganj, Siwan, Saran, Muzaffarpur and Vaishali.

The Burhi Gandak

It is known as the Sikarna in its upper reaches and rises in East Champaran district from the springs of the Sumeshwar hills at an elevation of 300 meters above sea level located at 27^{0}22'North latitude 84^{0}8' East longitude. It has a drainage area of about 10,150 Square kilometers and flows for a total length of 320 kilometers. The river is practically a collection of hill torrents rising from springs in the beginning and then assumes the form of a river. After flowing for a distance of about 56 kilometers it takes a southerly and then southeasterly turn and flow through Muzaffarpur district for about 32 kilometers. Later on, after passing through Samastipur, Begusarai and Munger districts, it joins the river Ganga near Munger town. The rivers draining the area to the east of the Burhi Gandak and upto the Kosi are known as the Adhwara group of rivers. The most important of these are the Baghmati and

the Kamla. These rivers are characterized by their steep gradient in the Himalayan region and their flatten slopes lower down. This result in the dropping of silt load in the middle of the channel and consequently spill over of water leading to the transfer of flood water from one river to another. These rivers also have a tendency to shift their course to mature topography of the region. The river Baghmati, a tributary of river Burhi Gandak rises in Shivapuri hills of Nepal and after cutting, across the Mahabharat range of hills enters India at Rasulpur in Sitamarhi district and later on joins the river Burhi Gandak near village Barua in Samastipur district. It has a drainage area of 6,320 square kilometers in North Bihar and a length of 396 kilometers. The water of Baghmati carry vast amount of silt which, when deposited through floods in the nearly area, increases the fertility of land.

The Kosi

The river Kosi or 'Kaushiki' of the legends is the 'wildest' and the most uncertain among the Indian rivers (Pandey, 1961)[11]. The river rises in the Himalayan region Nepal Tibet at $27^0$58' North latitude and $87^0$51' East longitude. It is formed by the confluence of three streams, namely the Sun Kosi, the Arun Kosi and the Tamur Kosi. The river enters North Bihar Plain about 25 kilometers to the south of Chatra gorge. It is most notorious for changing its course and there is perhaps no river in India, which has changed its course as frequently as Kosi has done (Central Ground Water Board, 1984)[12]. It has a tendency to change its course generally in a westward direction. During the course of the last 200 years, the river has shifted westwards for a distance of about 112 kilometers and has laid waste by depositing coarse silt extensive tracts of agricultural land in the Darbhanga, Purnia and Katihar district. A barrage has been constructed at Hanumannagar for preventing the river moving side ways and for storing water for irrigation. Two canals take off on either side of the river and irrigate about 1.04 million hectares in Darbhanga, Purnia and Saharsa districts.

The Mahananda

It rises at $26^0$58' North latitude and $88^0$9' East longitude in the Mahaldiran hills of the Himalayas in the Darjeeling district of West Bengal at

an elevation of 2,100 meters. The river enters into North Bihar Plain in the northeast corner of district Purnia and after covering a distance of 376 kilometers finally leaves the area at the eastern tip of Katihar district. On its later journey, the river passes through West Bengal and joins the river Ganga at Godagiri.

CLIMATE

The North Bihar Plain experiences a tropical monsoon climate characterized by a rhythm of seasons owing to reversal of winds direction, which is southwest in summer and the northeast in winter. The whole year is divided into three main seasons corresponding to three agricultural seasons of the area. These seasons are: I. The Rainy Season (mid June to October) corresponding to Kharif agricultural season characterized by cloudy sky, high humidity and heavy rainfall, II. The Cold Weather Season (Nov. to mid-March) corresponding to agricultural season known as rabi and characterized by low temperatures, clear sky, little rainfall and low humidity and III. The Hot Weather Season (mid-March to mid-June) corresponding to agricultural season known as garma famous for high temperatures, very low humidity and the prevalence of hot dusty winds.

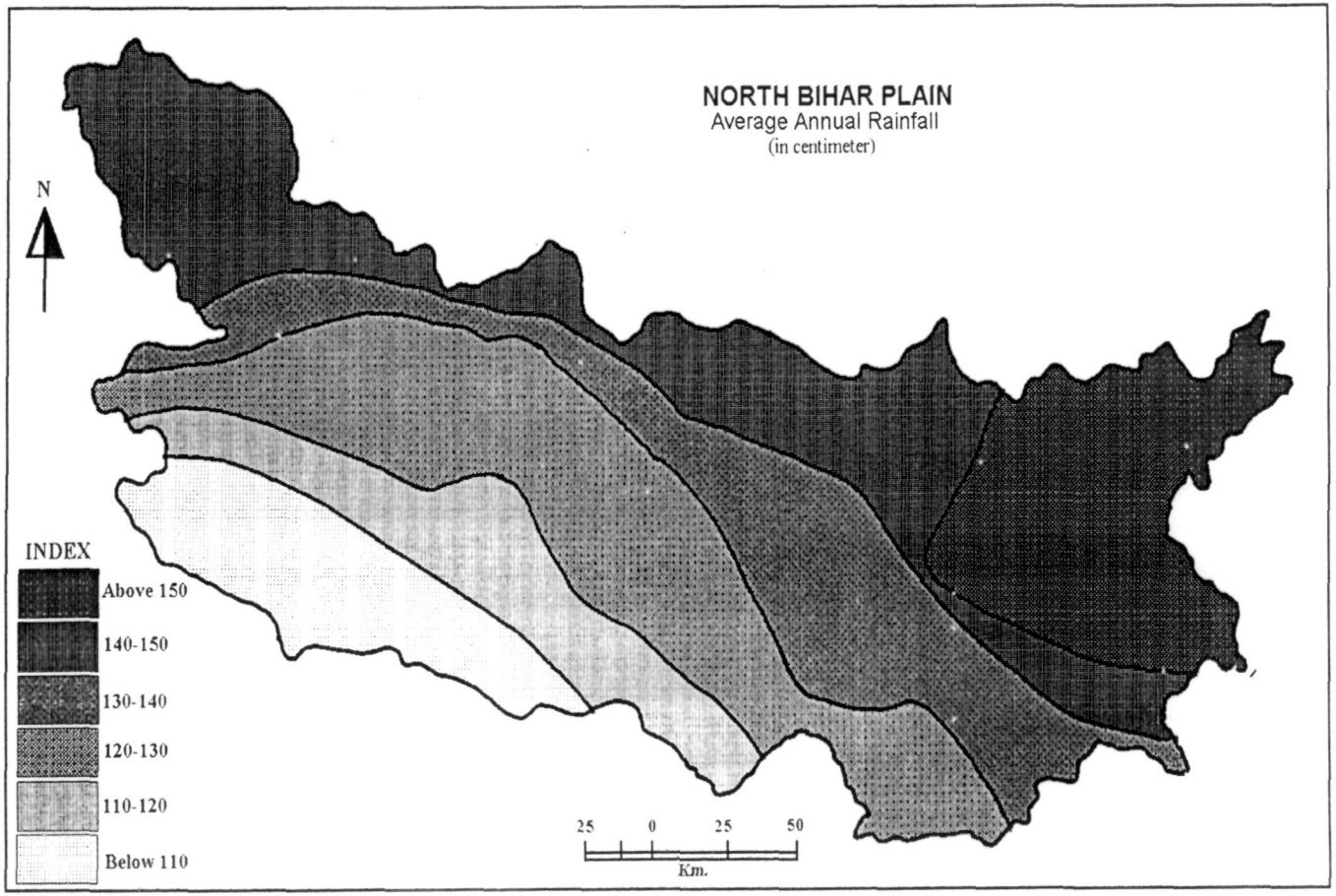
I. The Season of General Rains (Mid-June to October)

The season of general rains starts from the mid June and continues up to October. Nearly, 90 per cent of the annual rainfall is received in this season. The mean maximum temperature ranges between 32.3°C and 33.6°C, whereas, the mean minimum temperature ranges between 24.3°C and 24.5°C, and the mean monthly temperature oscillates between 28.3°C and 29.0°C.With the onset of monsoon rain, the temperature slightly decreases and this trend of decrease in temperature continues throughout the months of rainy seasons. The monsoon winds cause heavy rains in the sub-mountain region along the northern boundary of North Bihar Plain and amount of rainfall ranges between 140 cms. and 150 cms. The winds blow from east to west with an average velocity of 6.10 Km/hr. (Blandford, 1989)[13]. The amount of rainfall decreases as the monsoon winds moves westward.

Table 1.1 Mean Monthly Rainfall

Stations		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Bhagalpur	RF	2.0	0.8	0.8	1.9	5.4	18.3	26.0	23.0	22.8	8.3	0.4	0.4
Chapra	RF	2.1	1.0	0.9	0.7	2.6	11.9	28.8	26.1	21.6	5.9	1.1	0.3
Darbhanga	RF	1.9	1.0	0.9	2.0	6.3	16.9	31.0	27.7	20.0	8.3	1.1	0.3
Motihari	RF	1.6	1.1	1.3	1.3	4.6	19.7	36.5	27.4	26.6	4.3	0.3	0.1
Muzaffarpur	RF	1.5	0.7	0.6	1.1	4.7	16.6	33.3	29.9	22.5	7.0	0.8	0.2
Purnia	RF	1.5	0.7	1.5	2.9	9.4	22.7	36.1	29.2	24.4	10.8	1.1	0.4

Source: Climatological Tables of Observatories in India, Indian Meteorological Department, New Delhi
RF = Rainfall (cm)



Source: Based on Computed Data, Directorate of Statistics and Evaluation, Bihar, Patna.

Fig.1.3

II. The Cold Weather Season (November to mid March)

By the end of October the sky becomes clear, rains stop and there is a further fall in temperature heralding the beginning of a cold weather season from November. By December the cold weather season fully sets in. January is the coldest month recording a temperature of 15.2°C at Motihari in the northwestern side of the region and 15.5°C at Purnia on the eastern side.

It may be seen from Table 1.2, that the mean monthly temperature recorded at the stations of Motihari in the north western part and Purnia in the eastern part, during the month of November are 21.1°C and 20.5°C respectively. The mean minimum temperatures in the same month and at the same stations are 10.2°C and 9.7°C, while the mean maximum temperatures recorded are 32.0°C and 31.2°C respectively. The lowest temperature recorded in the month of January at Motihari and Purnia are 5.0°C and 4.1°C respectively. The mean maximum temperatures for the respective stations in the same month are 25.3°C and 26.9°C. By the month of February, temperature begins to rise but still remains low as compared to that of November (Table 1.2). A significant climatic feature of this season is the occurrence of fog (locally known as Kohra) in the early hours of morning, which adversely affects the cultivated crops of arhar, peas, gram, rapeseed and mustard.

Occasionally, the general fine weather of winter season is changed by winter rain brought by western disturbances during the months of December, January and February. This winter rain is beneficial for wheat crop in the region.

III. The Hot Weather Season (March to mid-June)

The hot weather season start from the month of March lasts till mid June. It is characterized by high temperature and low pressure. This increase in temperature reaches its highest in the month of May which continues through June until the onset of southwest monsoon. The mean maximum temperatures at Motihari and Purnia in the month of May are 40.9°C and 40.5°C, while the mean minimum temperatures for the same stations in the same month are 18.7°C and 18.4°C respectively (Table 1.2).

Table 1.2 Mean Monthly Maximum, Minimum and Average Temperature (^{O}C) in North Bihar Plain

Month	Bhagalpur			Chapra			Darbhanga			Motihari			Muzaffarpur			Purnia		
	Mean max.	Mean min.	Mean Monthly	Mean max.	Mean min.	Mean Monthly	Mean max.	Mean min.	Mean Monthly	Mean max.	Mean min.	Mean Monthly	Mean max.	Mean min.	Mean Monthly	Mean max.	Mean min.	Mean Monthly
January	27.4	8.4	17.9	26.5	7.1	16.8	26.3	6.4	16.4	25.3	5.0	15.2	26.0	6.4	16.2	26.9	4.1	15.5
February	32.0	9.8	20.9	32.0	8.3	20.2	30.0	7.8	18.9	30.1	6.5	18.3	30.7	6.5	18.6	31.1	5.5	18.3
March	38.2	14.4	26.3	37.9	12.5	25.2	36.1	11.6	23.9	36.3	10.2	23.3	36.3	10.7	23.5	37.0	9.4	23.2
April	41.4	19.3	30.4	41.6	17.7	29.7	39.5	16.5	28.0	39.6	14.7	27.2	39.6	16.0	27.8	40.1	19.9	27.5
May	42.2	20.3	31.4	43.1	21.3	32.2	41.2	19.0	30.1	40.9	18.7	29.8	40.9	20.4	30.7	40.5	18.4	29.5
June	40.9	22.8	31.9	42.5	23.3	32.9	40.0	21.3	30.7	39.9	21.1	30.5	39.5	22.5	31.0	38.2	21.1	29.7
July	36.4	23.8	30.1	37.3	23.3	30.3	26.3	22.5	29.4	36.4	22.8	29.6	36.7	23.9	30.3	34.8	22.8	28.8
August	35.5	24.2	29.9	35.9	23.9	29.9	35.4	22.9	29.2	35.4	23.2	29.3	35.3	23.2	29.3	34.8	22.9	28.9
September	35.8	23.5	29.7	35.3	23.1	29.2	35.5	22.4	29.0	35.0	22.0	28.5	35.2	22.4	28.8	35.2	21.9	28.6
October	34.6	19.2	26.9	34.5	19.0	26.8	34.3	18.4	26.4	34.4	16.7	25.6	33.8	17.8	25.8	34.0	16.2	25.1
November	32.0	13.4	22.7	32.0	12.3	22.2	31.2	12.2	21.7	32.0	10.2	21.1	31.4	10.8	21.1	31.2	9.7	20.5
December	28.4	9.5	19.0	27.8	7.8	17.8	27.8	7.9	17.9	27.4	6.3	16.9	27.0	7.1	17.1	28.1	5.7	16.9
Annual	**43.1**	**8.1**	**25.6**	**43.1**	**6.8**	**25.1**	**41.6**	**6.0**	**23.8**	**41.5**	**4.9**	**23.2**	**41.6**	**6.0**	**23.8**	**41.4**	**3.8**	**22.6**

Source: *Climatological Tables of Observations in India*, Indian Metrological Department, New Delhi

In the summer months, hot dry winds locally known as "Loo" are the regular phenomena and their intensity becomes greater in the months of May and June. The most characteristics feature of hot winds is their intense dryness and excessive temperature which causes sun strongest to the people and as a result many people die each year.

The occurrence of violent storms locally known as "Andhi" is the another phenomena of this season which lasts for a short time giving a reddish-yellow glare to the sunlight especially in the afternoon. Sometimes these storms bring a small amount of rain, which is of local nature.

SOILS

The soil of North Bihar Plain is thick alluvium deposited probably for the most part over Shiwalik and old Tertiary rocks. This drift alluvial soil is relatively young, and is constantly rejuvenated year after year by the deposition of sand and silt by numerous streams. It is deficient in phosphoric acid, nitrogen and humus, but potash and lime are usually present in sufficient quantity (Royal Commission on Agricultural in India, 1928)[14].

The soils of the region may by grouped into four broad categories: I. Swampy soils, II. The Ganga Alluvium, III. Calcareous soils and IV. Red and yellow light soils. The general distribution of these soil groups is given in Fig.1.4.

I. Swampy soils

These soils are found in the narrow belt of Tarai in the north of West Champaran district in the Shiwalik region. In extreme northern margin of this district a thin narrow belt of heterogeneous Himalayan soil is also found above the swampy soils. Swampy soils tract is conditioned by excessive moisture due to large amount of annual rainfall and continuous seepage of water from the northern sloping land. These soils remain saturated during the monsoon months and remain fairly moist during the succeeding winter owing to the presence of a high level of underground water. The soil is mostly clay of dark grey colour. Being clayey in nature these soils are highly retentive of

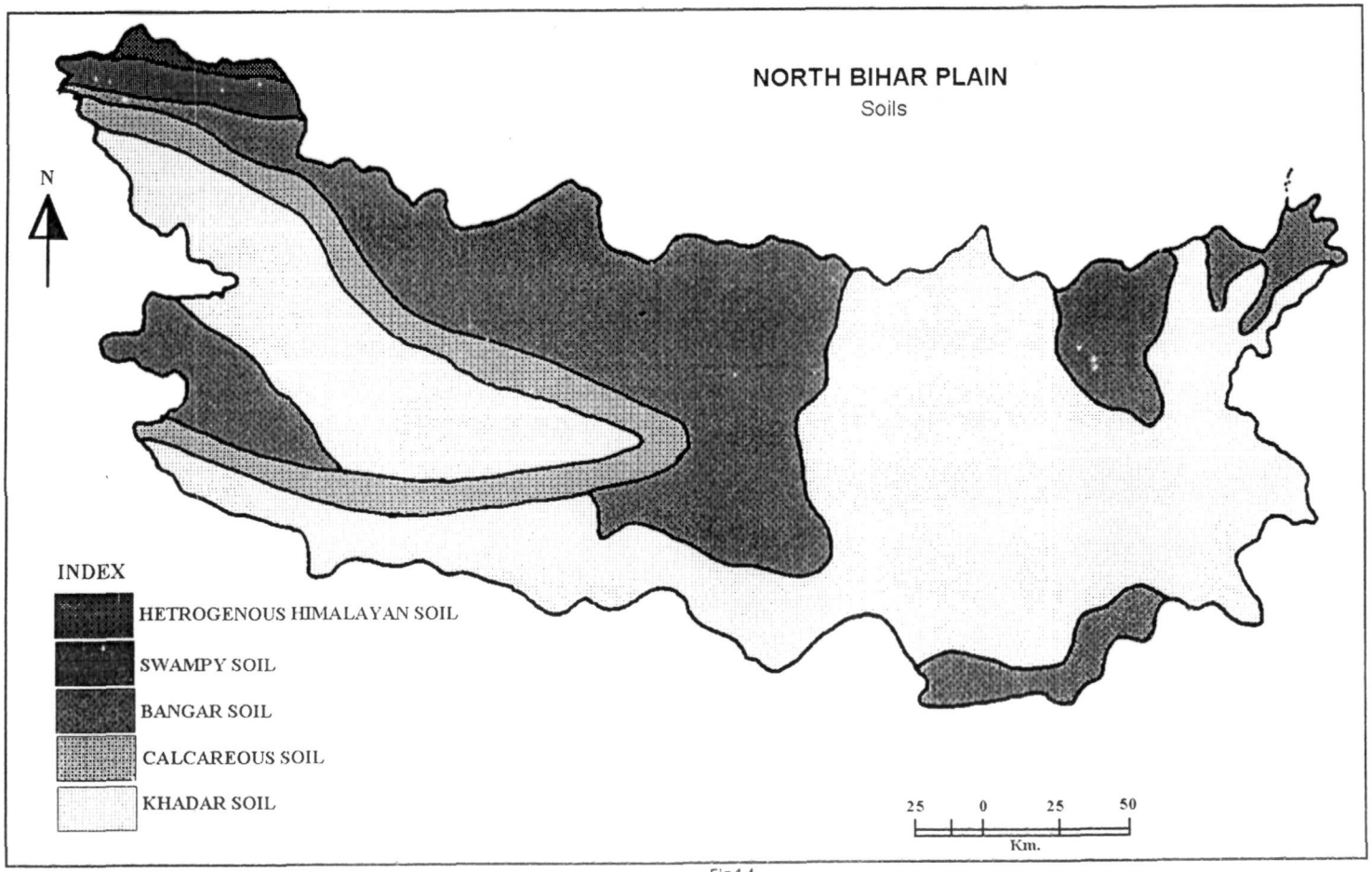


Fig.1.4

Source: Land Resource Atlas of India,NATMO,Calcutta,1996.

moisture, and are therefore most suitable for the cultivation of rice (Ahmad, 1995, p.60)[15].

II. The Ganga Alluvium

The Ganga alluvium covers a vast area along the banks of the rivers Ganga, Gandak, and Kosi. The soils of this group are generally light textured, light grey in colour and moderately alkaline in reaction with medium to high fertility status. The alluvium is mostly loamy in texture although sand and clay proportions vary from place to place. Variations in the fertility of soils from place to place, especially in the east where the rainfall is the heaviest, are not so much due to varying capacity of moisture retention. The PH value of these soils varies from nearly neutral to acidic in the non-calcareous zones of Saharsa.

The Ganga Alluvium can be divided into two types:

(a) Newer alluvium or khadar

(b) Older alluvium or bangar

(a) Newer alluvium or khadar: These soils are different from older alluvium or bangar in texture and chemical composition. The soils comprising the newer alluviums are grey to ash grey in colour, and clay loam to clay in texture. There are generally found along the banks of rivers and streams. There are generally highly leached and is low in humus and nitrogen and poor in lime newer alluvium is found along the river Gandak in the districts of West Champaran, East Champaran, Muzaffarpur, Vaishali and in a narrow belt along the river Ghaghara in Saran. There are more developed in the Kosi region. There soils are suitable for sugarcane, paddy and root crops. The whole of Saharsa is almost occupied by clayey soils. The soils of this area are low to medium in fertility, and are devoted to paddy and jute cultivation. This clay belt merges to the east into loamy and sandy loam soils of the Kosi belt.

(b) Older alluvium or bangar: are found some distance away from the main rivers. These are heavier soils with greater clay proportion than the khadar. The bangar of North Bihar Plain generally lie between the higher level of streams in low lying interfluves and is inundated by water during the rains

through spill channels which cut through the levees. Bangar lands form typical paddy areas of North Bihar Plain. There are is also found in Muzaffarpur, northern parts of Bhagalpur, Munger and in a small patch of Begusarai district.

III. Calcareous Soils

There are found in the Tirhut Division of northern western Bihar plain. The belt of this soil roughly corresponds with the bangar area of Gopalganj, Siwan and Saran and also the khadar tract of the Gandak in West Champaran and East Champaran. These soils are well developed and occupies whole of the Muzaffarpur and the western part of Darbhanga. The presence of a bed of Kankar nodules is a common feature in the subsoil. The clay has not undergone any marked translocation from surface to lower layers and a retarded leaching has led to the accumulation of calcium carbonate even in the surface soil. Calcareous soil is more useful for lichi plants. This soil is highly rich in lime.

IV. Red and Yellow Light Soils

This soil is found only in two districts, Bhagalpur and Munger, in the southern part of the region. It is formed from schistose rocks and is deficient in nitrogen, phosphoric acid and humus. Laterite is found on higher levels at the southern margin of Bhagalpur district. This soil is good for arhar and castor crops. The red colour is due to presence of iron oxides. The red and yellow light soils of extreme southern margin of Munger and Bhagalpur may be regarded as laterite formation.

LAND UTILIZATION

Broadly speaking, we can bring all the different uses of land into two major classes of land, viz., arable and non-arable land. The land use categories of net sown area, current fallow, other fallow, groves and orchards can conveniently be put under arable group. This includes all the different categories of cultivable land, whereas the landuse categories of culturable waste, barren lands, permanent pastures, landput to non agricultural uses in the existing circumstances are grouped as non arable land.

Table 1.3 Land use Pattern in North Bihar Plain (Unit in hect.)

Geographical Area (Reporting Area)	5501513
I. Forest Land	95031 (1.72%)
II. Barren and Uncultivable Land	226139 (4.110%)
III. Land put to Non- Agricultural Uses	1091848 (19.84%)
IV. Culturable Waste Land	20083 (0.36%)
V. Permanent Pastures and Grazing Land	9536 (0.17%)
VI. Land Under Miscellaneous Trees, Crops and Groves (not included in net sown area).	208423 (3.78%)
VII. Fallow Lands	321355 (5.84%)
VIII. Net Sown Area	3560104 (64.71%)
IX. Area Sown More Than Once	1681924 (30.57%)
X. Total Cropped Area	5242028 (95.28%)

Note: Figures in parentheses refer to the percentages computed from the total geographical area.

Source: Bihar Through Figures (2001), Directorate of Statistics and Evaluation, Bihar, Patna.

Total reporting area in North Bihar Plain for land utilization purposes was estimated 5501 thousand hectares during the period 2001(Table 1.3).

I. Forest Land

Forest land of the total reporting area of North Bihar Plain accounts for only 1.72 per cent. Most of the forested area is mainly confined to the West Champaran, East Champaran, Bhagalpur, Katihar, Kishenganj, Araria and Purnia districts and West Champaran accounts for 96.54 per cent of the total forested area. This area is largely covered with a wild vegetative growth. There are vast stretches of bamboo, sal and seesam. However, with the increasing population pressure and bringing of more and more area under cultivation, the area under forest has constantly decreased.

II. Barren and Uncultivated Land

This category includes all such lands which are practically useless or unproductive and virtually unfit for cultivation. This area is covered by sandy soils where not a single blade of vegetation grows. The area under barren and uncultivated land accountes for 4.11 per cent of the total reporting area.

III. Land Under Non-Agricultural Uses

This land is not available for cultivation, though, they are considered to be arable lands. This category covers the land, which has a wide range of uses and to include all the lands, which are under settlements, factories, roads, canals and reservoirs etc. The Table1.3 indicates that 19.48 per cent area lying under non –agricultural uses of the total reported area.

IV. Miscellaneous Trees, Crops and Groves

The cultivation of orchards and plantations is done in this class of lands which occupies 208 thousands hectares (3.78 per cent). The districts of Araria, Madhubani, East Champaran and Sitamarhi have recorded the highest area under this category during the 2001. These districts have a high percentage of land, which has the plantation of mango and lichi (Litchi chinensis) over extensive areas.

V. Permanent Pastures and Graizing Lands

Taking the North Bihar Plain as a whole, the area under pastures and grazing land is not very appreciable. This accounts for 9 thousands hectares (0.193 per cent) of the total reporting area of the region. The table (1.3) shows that the most of the pasture lands occur in the districts of Sitamarhi, West Champaran, Madhubani and Saharsa.

VI. Culturable Waste Lands

The lands under this category may put for cultivation but presently they are laying waste due to a number of reasons. The reasons may be enumerated as: encroachment by Jungly weeds of kans and patters, floods and erosin, poor, scarcity of water etc. There is a, very low percentage of the area

as culturable waste land in North Bihar Plain as shown in Table 1.3 (0.36 per cent).

VII. Fallow Land

Fallow land is a part of cultivated land, but it is kept uncultivated for one year in order to replacements its fertility naturally, the area covered by this class. The highest percentage of fallow land is found in the districts of Katihar (17.16 per cent) and the lowest is recorded in Champaran districts (1.89 per cent) during 2001.Cropping and fallowing of land is generally practiced alternatively so that in the typical sandy soil areas, a fraction of arable land is actually given to crops while the rest may be referred to as either 'current fallows' or 'other fallows. This practice prevents soil exhaustion and ensures better yields of crops in the year of its cultivation. The eastern part of the region suffers mostly from devastating floods each year by rivers, so that as a result a considerable percentage of area remains uncultivated. The districts lying in the eastern part of the region share a high percentage of fallow lands as compare to those which from the Western part.

The concentration of fallow land also varies in accordance with the amount of rainfall; in the years of good rain, the percentage of fallow land decreases, whereas in the years with insufficient rain, the proportion of such land increases.

Table 1.3 shows that during 2001, net sown area was reported 3,560 thousand hectares (64.71 per cent). There are marked variations among the districts of North Bihar Plain with respect to the net sown area. The districts of Saran, Siwan, Gopalganj, Muzaffarpur and Madhepura have the high proportion of area under the category of net sown area, whereas, the districts of West Champaran, Madhubani and Katihar have the low percentage of area in the same category.

Soil characteristics are the main factors of variation in the distribution of net cultivated area in the region. Other factors which may be accounted for are: a continued population pressure, a substantial rise in prices of individual commodities, an increasing demand of food grains, government efforts in extension services to the farmers etc.

When more than once crops are grown on the same field in the same year is include in this category. In North Bihar Plain, the area under this class recorded 1,681 thousand hectares (30.57 per cent) during the study period. The highest percentage of Gross area is found in the districts of Saharsa (74.37 per cent) and the lowest is recorded in East Champaran (12.82 per cent).

CROPPING PATTERN

Cropping pattern means the proportion of area under various crops at a point of time (Kanwar, 1968)[16]. It also refers to the relative arrangement of crops on a farm, region, province or country giving due consideration to natural factors (climate and soil), crop efficiency, land capability, socio-economic structure, technological and infrastructural extension and the national agricultural policy (Pal et al., 1985)[17]. Cropping pattern may be also be defined as the yearly sequence and spatial management of crops on a given area which have been based on cropping pattern zones developed to divide the country into homogenous units using the utilities like soil and climate besides physical and agronomic criteria subdivided on the basis of isothermic lines (Saran et al., 1989)[18].

In order to analyze the cropping pattern in the region it would be worthwhile to give some idea about the crops, their sowing and harvesting periods.

Agricultural practices in North Bihar Plain revolve around two main seasons namely, kharif and rabi. The sowing in the kharif season (Summer crops) begins generally with the onset of the southwest monsoon in mid-June, while the rabi season (Winter crops) starts with the beginning of cold weather i.e., by the end of the month of October or early November. The important crops grown in kharif season are: rice (oryza sativa), maize (Zea mays), Jowar (Sorghum vulgar) bajra (Penniscelum typhoideum), arhar (cajanus indicus) and sugarcane (Saccharum officinrum), which require relatively high temperatures and plentiful moisture. The crops grown in rabi season are: wheat (Triticum sativum), barley (Hardeun vulgare), masoor (lens culinaris), gram (cicer arietinum), peas (Pisum sativum), mustard (Brassica sp.), potato (Solanum tuberosum), linseed (Linum usitatissimum), which require low temperatures and moderate amount of moisture during the period of

their growth. The harvesting period of kharif crops starts from the months of September to October while rabi crops are harvested generally during the months of March to April and which may extend sometimes by the month of May. Table 1.4 shows the sowing and harvesting periods of major crops grown in North Bihar Plain.

Table 1.4 Time of Saving and Harvesting of Crops

S. No.	Name of Crops	Sowing Time	Harvesting Time
1.	Rice	Mid June-August	November-December
2.	Maize	June-July	September-October
3.	Wheat	November-January.	Mid March-April
4.	Barley	November.-December.	March-April
5.	Bajra	June-July	September-October
6.	Arhar	June-July	December-April
7.	Gram	October.-November	March-April
8.	Potato (rabi)	October.-mid January	September-mid March
9.	Sugarcane	October.-March	January.-March
10.	Linseed	October-December	January-March
11.	Sesamum	June-July	September-November

Source: Annual Season Bihar, Patna and Crop Report (1977-78), Directorate of Statistics and Evaluation.

Important crops grown in the study area are cereals which include rice, wheat, maize, barley, pulse crops such as gram, arhar, masoor, khesari and peas, Important oilseeds grown are rapaseed-mustard, linseed, seasamum and cash crops include sugarcane, potato, jute, tobacco. Table 1.5 shows various crops with respect of area, production and yield of crops in North Bihar Plain.

Various crops are grown in every corner in of the study area due to high density of population and demand of agricultural commodities. Cereal is the most dominant crop in the study area which occupied 4,254 thousand hectares or 86.94 per cent of the total cropped area during the 2001. Variation in area, production and yield of the major crops is shown in Table 1.5. Rice,

the most significant crop and is grown in all districts and covers about 50.27 per cent of the total cropped area. The cropped area of rice crops varies from 56.64 per cent in Kishenganj and 21.18 per cent in Sitamarhi district. Out of the twenty-two districts, more than 40 per cent of the cropped area under rice are Darbhanga, Bhagalpur, Saharsa, Purnia, Katihar, Madhepura, Supaul, Araria and Kishenganj. Only Darbhanga district is located in central part of the study area and the others are in eastern North Bihar Plain. So, rice occupies the major part of the cropped area in eastern districts of the region. These districts receive high amount of rainfall during rainy season which support the cultivation of rice. Its low concentration is limited to a small area which extends sporadically over the districts of West Champaran, Supaul, Sitamarhi, Madhubani, Samastipur and Khagaria.

Table 1.5 Crop-wise Distributions of Area, Production and Yield in North Bihar Plain 2000-2001

Crops	Area		Production	Yield
	Hectare	%		
Rice	2460	50.27	3013	12.19
Wheat	1344	27.99	2861	21.20
Maize	439	12.63	1068	23.96
Barley	11	0.22	16	11.42
Total Cereals	4254	86.94	6958	16.35
Pulses	166	3.39	120	7.65
Total Foodgrains	4420	90.33	7078	18.88
Oilseeds	115	2.35	94	8.17
Sugarcane	102	2.03	4111	403.03
Potato	112	2.28	128	11.42
Jute	134	2.73	1096	81.79
Tobacco	10	0.20	17	17.00
Total Cash crops	358	7.31	6570	18.35
Total	**4893**		**14303**	**29.23**

Area in 000'ha,Production in 000'm. tones, Yield=in qnts/ha.

Source: *Bihar Through Figures (2001), Directorate of Statistical and Evaluation, Bihar,Patna.*

Wheat is the second ranking crops of the study region and occupies about 27.99 per cent of the total cropped area. It occupies a significant proportion of the cropped area in Darbhanga (40.26%), Saran (36.68%), Siwan (37.0%), Gopalganj (35.47%) and Begusarai (34.25%). Maize is the third important crop in the region. Maize occupies the highest percentage of the cropped area in Sheohar (41.07%), Begusarai (35.91%), Khagaria (35.91%) and Bhagalpur (30.28%) lowest in Madhubani (0.67%) districts.

Other crops like jute, tobacco, pulses, potatoes and sugarcane are also produced in the region, but their percentages of cropped area are very small compared to rice, wheat and maize.

Jute occupies the only 2.73 of the total cropped area. It is confined to only eastern districts of the study region. Potato is another food cum cash crop yielding sizeable income to the cultivators. Tobacco is the principal crops in Samastipur districts. Sugarcane is confined to only fifteen districts. Highest concentration is in western districts of the North Bihar Plain.

Pulses are important crops in Begusarai (7.73%), Khagaria (5.63%), West Champaran (4.78%) and Sitamarhi (4.17%) districts.

Oilseeds occupy a significant proportion of the cropped area in Supaul (5.69%), Madhepura (4.60%), Begusarai (4.97%) and West Champaran (4.16%).

POPULATION DENSITY

Population density is simply defined as man and land ratio which shows the concentration of population per square km. The overall density of population of the region in year 1991 was 778 persons per square km. that increased to 1005 in 2001. The study area with 54.17 million persons and 55.0 thousand square km. of land area has been 1005 persons per square km. (2001). This density is much higher than the national average of (324) and state of Bihar of (880), mainly due to the fact that the study area has most fertile tract of the Indo-Gangetic plain.

Table 1.6 Districtwise Distribution of Population Density in North Bihar Plain 2001

Sr. No.	Districts	Total Population	Population Density
1	Saran	3251474	1231
2	Siwan	2708840	1221
3	Gopalganj	2149343	1057
4	East Champaran	3933636	991
5	West Champaran	3043044	582
6	Muzaffarpur	3743836	1180
7	Vaishali	2712389	1332
8	Sitamarhi	2669887	1214
9	Darbhanga	3285473	1442
10	Madhubani	3570651	1020
11	Samastipur	3413413	1175
12	Begusarai	2342989	1222
13	Bhagalpur	2430331	946
14	Saharsa	1506418	885
15	Purnia	2540788	787
16	Katihar	2389533	782
17	Madhepura	1524596	853
18	Khagaria	1276677	**859**
19	Supaul	1745069	724
20	Araria	2124831	751
21	Kishenganj	1294063	687
22	Sheohar	514288	1161
North Bihar Plain		**54171569**	**1005**

Source: The Census of India, 2001, Series II, Bihar

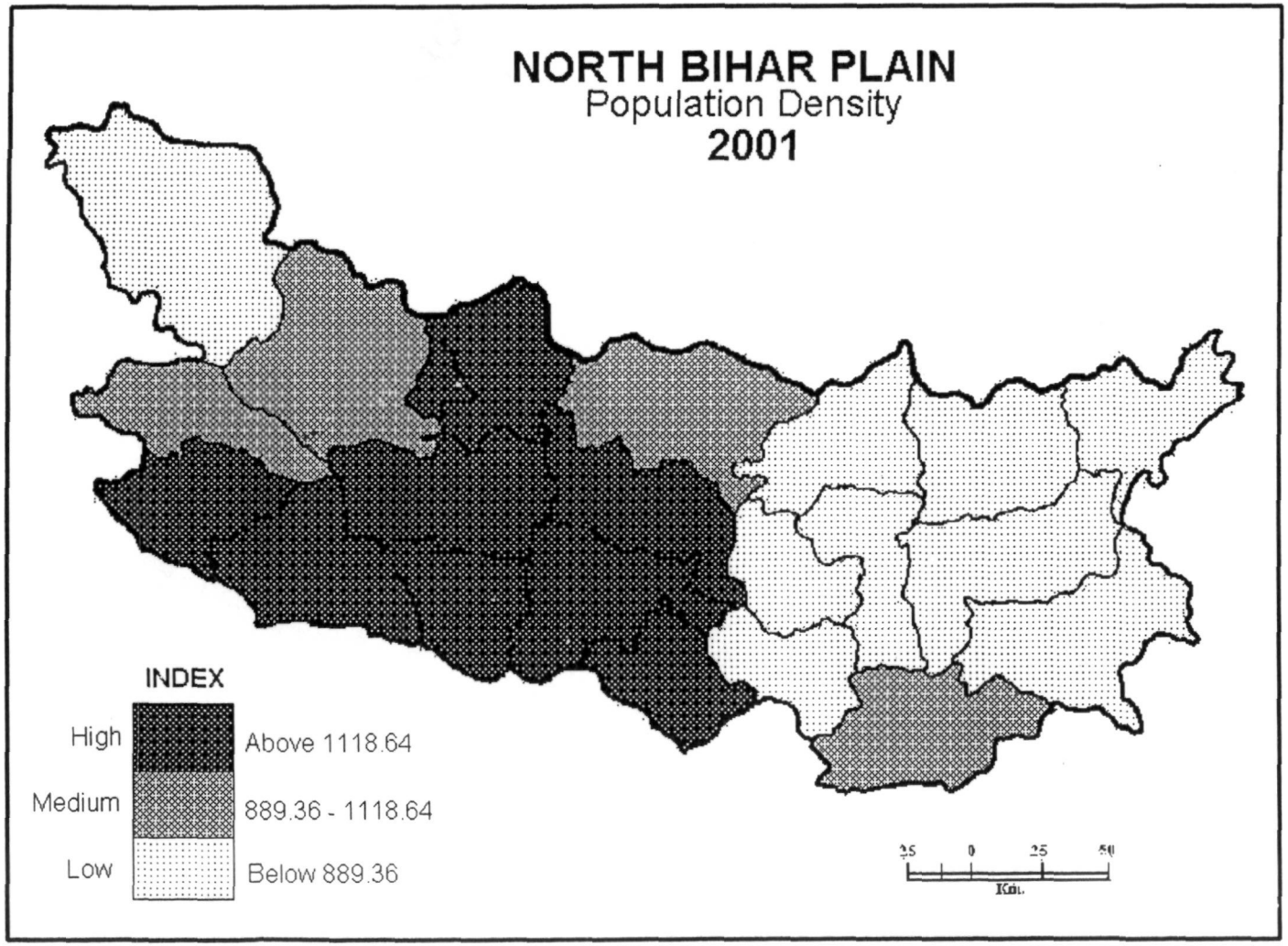

NORTH BIHAR PLAIN
Population Density
2001
INDEX
High
Above 1118.64
Medium
889.36 - 1118.64
Low
Below 889.36
25 0 25 50
Kms.

Fig.1.5

The interdistricts distribution of population density during the 2001 varies from 582 persons per square km. in West Champaran to 1442 person per square km. in Darbhanga district. The second highest district is Vaishali, which records 1332 persons per square km.

Fig. 1.5 shows that about 40.91 per cent districts of high population density region are found in the western part of the study area. These include the districts of Darbhanga, (1442), Vaishali (1332), Saran (1231), Begusarai (1222), Siwan (1221), Sitamarhi (1214), Muzaffarpur (1180), Samastipur (1175) and Sheohar (1161).

The distribution shows that 18.18 per cent districts have the moderate population density ranging between 889.36 to 1118.64 persons per sq.km. These districts are scattered over the region and consist of Gopalganj (1057), Madhubani (1020), East Champaran (991) and Bhagalpur (946).

Under low category of population density, a prominent region is observed in eastern part of the North Bihar Plain. They are Saharsa (885), Khagaria (859), Madhepura (853), Purnia(787), Katihar (782), Araria (751), Supaul (724), Kishenganj (687) and West Champaran (582). Only West Champaran district having low population density located is the in north- west corner of the study area.

Broadly speaking the high-density region is found in the western part and low in the eastern part of the region. Generally, the high-density regions are those areas, which are agriculturally more productive and have concentration of other resources. These areas are also comparatively less prone to the occurrence of flood.

WORK FORCE

Percentage of work force to the total population reflects the economically active working population (15-60 age groups). Table 1.7 indicates spatial pattern of disparity in working force to the total population in the study area. The less developed areas have high percentage of working forces to the total population like Khagaria (46.17), Madhepura (44.86) and Supaul (41.73). The medium range of working force covers large parts of the

Table 1.7 Districtwise Distribution of Total Workers in North Bihar Plain 2001

Sr. No.	Districts	Total Workers (in per cent)
1	Saran	26.56
2	Siwan	26.76
3	Gopalganj	28.28
4	East Champaran	31.56
5	West Champaran	37.92
6	Muzaffarpur	30.44
7	Vaishali	28.85
8	Sitamarhi	32.02
9	Darbhanga	31.30
10	Madhubani	34.38
11	Samastipur	31.40
12	Begusarai	25.08
13	Bhagalpur	35.19
14	Saharsa	39.13
15	Purnia	37.81
16	Katihar	37.59
17	Madhepura	44.86
18	Khagaria	46.17
19	Supaul	41.73
20	Araria	39.06
21	Kishenganj	32.23
22	Sheohar	31.34
North Bihar Plain		**30.73**

Source: Census of India 2001, Series -1, Primary Census Abstract, Total Population: Table A-5, Registrar General and Census Commissioner India.

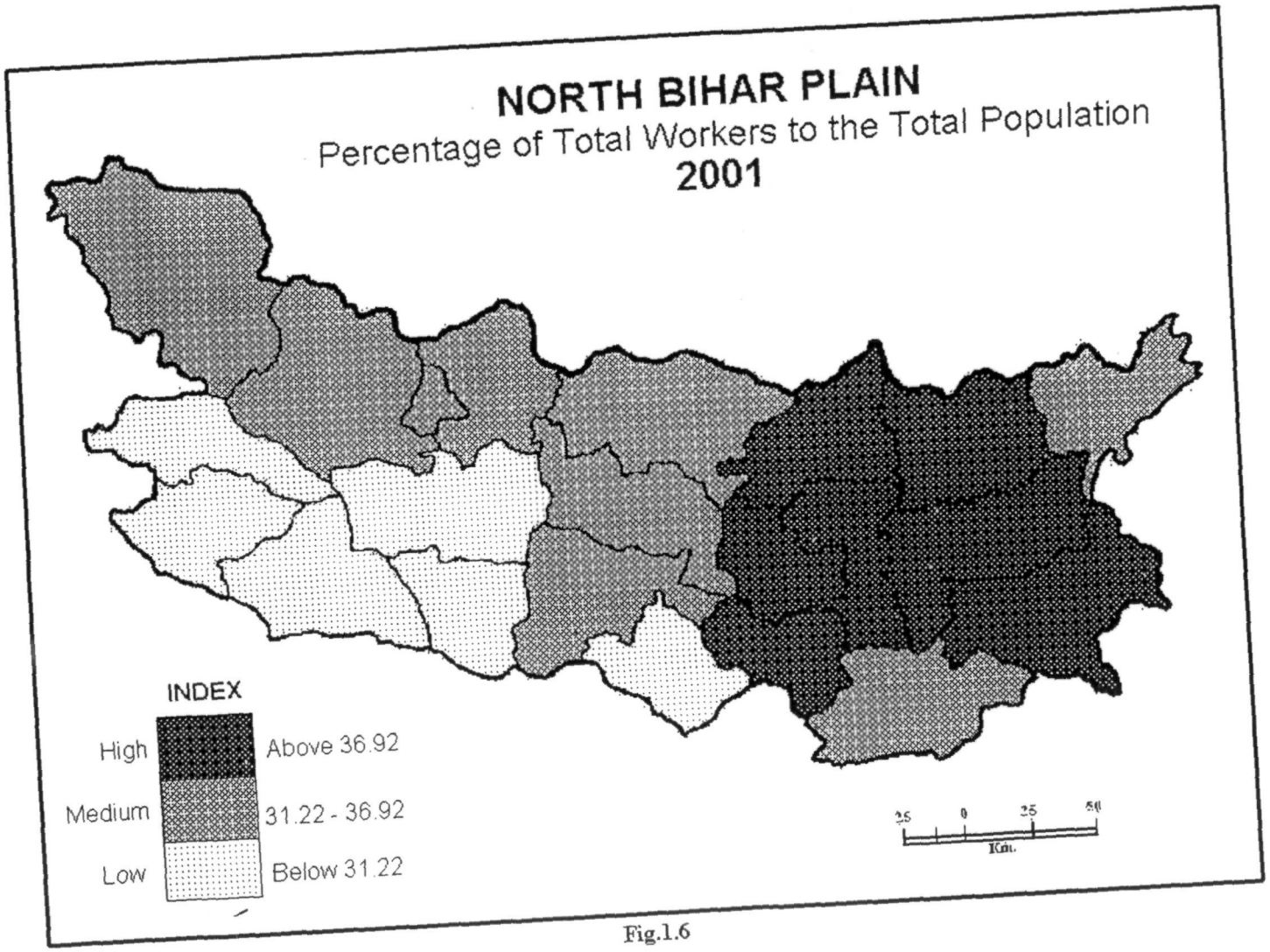

NORTH BIHAR PLAIN
Percentage of Total Workers to the Total Population
2001
INDEX
High
Above 36.92
Medium
31.22 - 36.92
Low
Below 31.22
25
0
25
50
Km.

Fig.1.6

region. This region including the districts of East Champaran(31.56), West Champaran (37.92), Muzaffarpur (30.44), Sitamarhi(32.02), Darhhanga (31.30), Madhubani (34.38), Samastipur (31.40), Bhagalpur (35.19), Saharsa (39.13), Purnia (37.84), Katihar (37.59), Araria (39.06), Kishenganj (32.23) and Sheohar (31.34). The districts recording low percentage of work force to the total population are Saran (26.56), Siwan (26.76), Gopalganj (28.28), Vaishali (28.85) and Begusarai (25.08).

INDUSTRIES

Selection of registered working factories as one of indicators to measure the industrialization and its impact on the development of the economy in general has been taken into account in the study. Industrialization tends to render a better ways of life as compared to a backward rural based economy.

North Bihar, which is an agricultural region, has many industries associated with agricultural products. There are numerous sugar factories scattered throughout the region. Many rice and edible oil mills also dot the landscape. It also has some Sundry, but important manufacturing plants, for example the bottom factory at Mehsi (East Champaran) and the old and renowned rail wagon manufacturing plant, the Arthur Butler Co. at Muzaffarpur. Immediately after independence however, a major industrial complex grew around Barauni. The industrial plants located there are; the fertilizer factory, the Oil (petroleum) Refinery plant, and the Thermal Power station. Recently, a thermal power plant has also begun Operation at Kanti, in the Muzaffarpur district along its boarder with East Chanparan (Butt and Gopal).[19]

In spite of these, North Bihar Plain is one of the industrially backward regions of the state in the country. Table 1.8 indicates the disparity in the level of industrial development. A high concentration of industries is found in Samastipur (12.27), Begusarai (43.27) and Katihar (11.46) and numbers of persons employed in these factories are high as compared to other districts.

A well-marked region of medium level of industrialization is found in major part of the region comprising the districts of Saran (7.78), Gopalganj (2.83), East Champaran (5.31), West Champaran (3.35), Muzaffarpur (6.62),

Table 1.8 Working Factories and Number of Workers Employed in North Bihar Plain 2001

Sr. No.	Districts	Registered Factories per Lakh Population	Employment in Factories per Thousand Population
1	Saran	7.78	0.47
2	Siwan	1.51	0.07
3	Gopalganj	2.83	0.12
4	East Champaran	5.31	0.60
5	West Champaran	3.35	1.77
6	Muzaffarpur	6.62	1.87
7	Vaishali	8.77	0.88
8	Sitamarhi	2.50	0.29
9	Darbhanga	6.72	0.86
10	Madhubani	1.62	0.68
11	Samastipur	12.27	1.58
12	Begusarai	43.27	1.07
13	Bhagalpur	4.93	0.52
14	Saharsa	3.65	0.29
15	Purnia	6.25	0.21
16	Katihar	11.46	1.05
17	Madhepura	3.80	0.29
18	Khagaria	9.39	0.39
19	Supaul	1.77	0.21
20	Araria	3.01	0.04
21	Kishenganj	8.2	0.19
22	Sheohar	0.97	0.01
North Bihar Plain		**66.76**	**6.75**

Source: Office of Chief Inspector of Factories, Bihar, Patna.

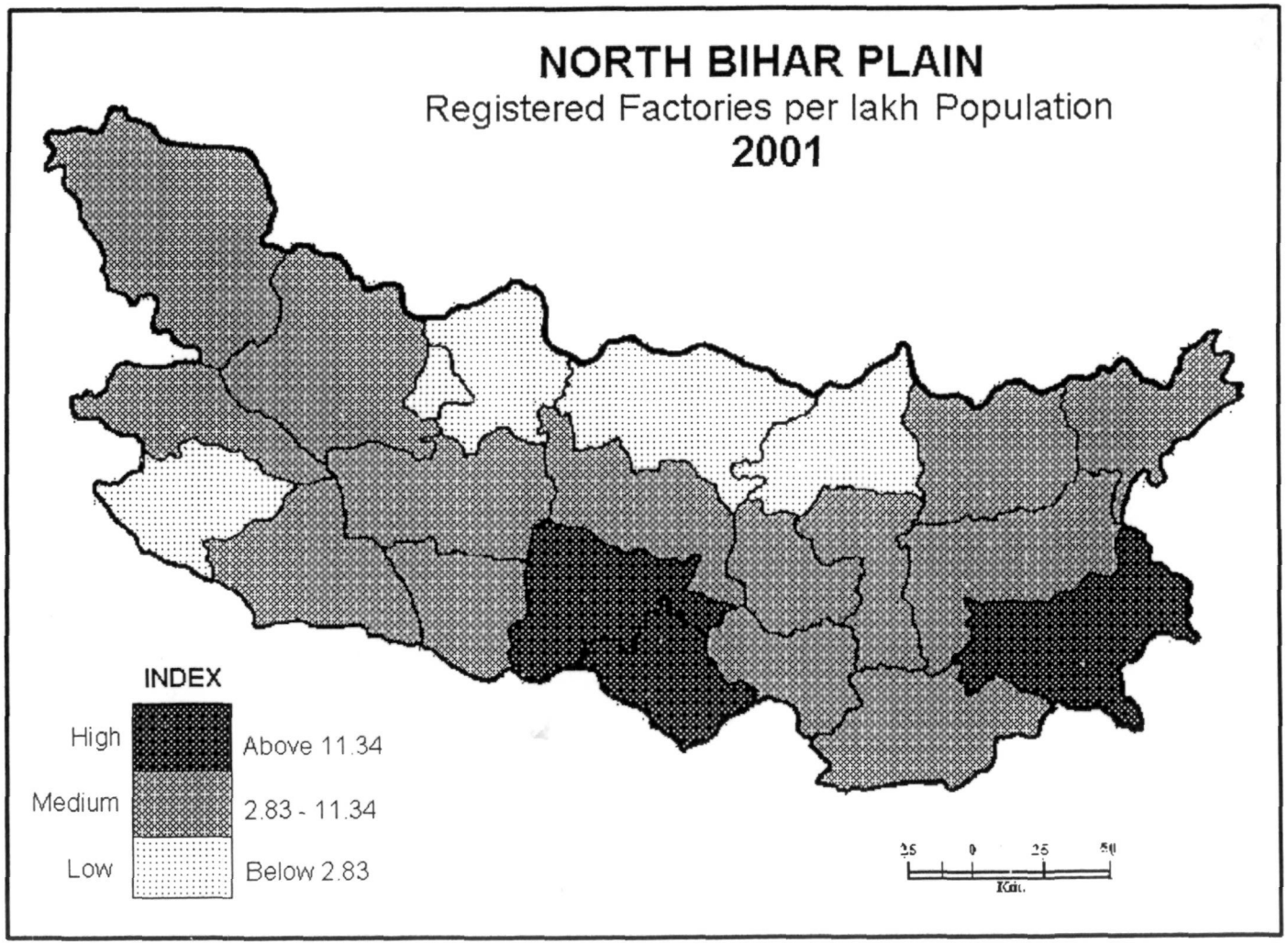

NORTH BIHAR PLAIN
Registered Factories per lakh Population
2001
INDEX
High
Above 11.34
Medium
2.83 - 11.34
Low
Below 2.83
25 0 25 50
Km.

Fig.1.7

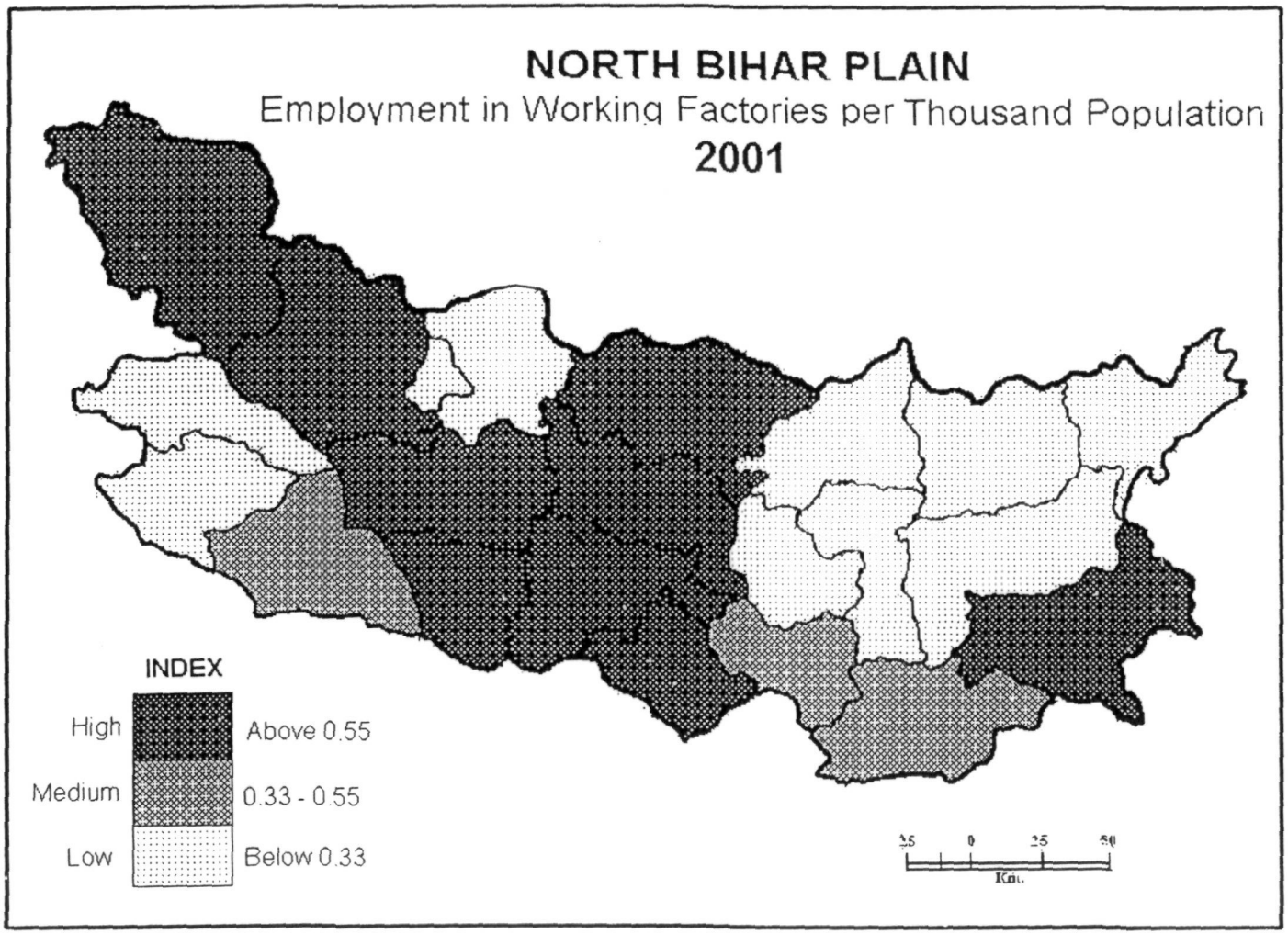

NORTH BIHAR PLAIN
Employment in Working Factories per Thousand Population
2001
INDEX
High
Above 0.55
Medium
0.33 - 0.55
Low
Below 0.33
25
0
25
50
Km.

Fig.1.8

Vaishali (8.77), Darbhanga (6.72), Bhagalpur (4.93), Saharsha (3.65), Purnia (6.25), Madhepura (3.80), Khagaria (9.39), Araria (3.01) and Kishenganj (8.20).

Low level of industrial development is found in the districts of Siwan (1.51), Sitamarhi (2.50), Madhubani (1.62), Supaul (1.77) and Sheohar (0.97).

REFERENCES

1. Wadia, D. N. (1939): Geology of India, p.364.
2. Burrard, S. G. (1912): On the Origin of Himalaya Mountains. Professional paper No. 12, Geological Survey of India, Calcutta, p.11.
3. Krishnan, M. S. (1956): Geology of India and Burma, Madras p. 511.
4. Krishnan, M.S., Ibid. p. 529.
5. Oldham, R.D. (1917): The Structure of the Himalayas and of the Gangetic Plain, Memories of the Geological Survey of India, Vol. 42, Part II, Calcutta, p. 82.
6. Cowle, H.M.(1921): A Criticism of R.D. Oldham's Paper on 'The Structure of the Himalayas and of the Gangetic Plain, elucidated by Geodetic observations in India', Professional Paper No. 18, Memories of the Geological Survey of India, Dehradun, p.6.
7. Krishna, M.S., op.cit. p. 512.
8. O'malley,L.S.S. Bengal District Gazetter: Purnia (Calcutta,1911) p.3
9. Report of the Irrigation Commission, Ministry Of Irrigation and Power (1972), Vol. III (Part I), New Delhi, p.131.
10. Ahmed, E. (1946-47): Hwangho of Bihar, *Aligarh Magazine*, Aligarh Muslim University, p.105.
11. Pandey, M. S. (1961): The Rainy Season in Bihar, *Geographical Review of India,* 23, No. I.
12. Waterlogged Areas in India, Unpublished Report Of Central_Ground Water Board, New Delhi, May 1984, pp.12-14.
13. Blandford, H.F. (1989): Climates and Weather of India, London, pp. 81-208.
14. Royal Commission on Agriculture in India, 1928, p.72.
15. Ahmad, E. (1995): A Physical, Economic and Regional Geography, Ranchi, p. 60.
16. Kanwar, J.S. (1968): 'Cropping Patterns Scope and Concept, Proceedings of the Symposium on Cropping Pattern in India' ICAR, p.13.

17. Pal, M.,et al, (1985): Cropping System Research. Concepts, needs and directions: In (ed. M. pal) proc. Natn. Symp. Cropping Systems, Indian soc. Agron. , IARI, New Delhi, pp. 1-20.

18. Saran, G., Ahlawat, IPS. And Vaduraju (1989): Agronomic Terminology, Indian Soc. Agron., IARI, New Delhi.

19. Batt, S.C. and Gopal, K. (2001): Land & People of Indian States & Union Territotries in 36 Volumes, Bihar, pp.238-239.

Chapter II

CONCEPT OF FOOD SECURITY

The term food security for the first time was used in the World-Food Conference held at Rome in 1974 in which the attention of world Community was drawn towards problems of hunger and starvation of million of people in the World. The conference was organized by FAO (Food and Agricultural Organization)[1] in the wake of 1972–74 world food crisis, made a call for ending hunger by 1984, which led to the development of the concept of food security as physical and economic access to food to all people at all time. It was realized in the Conference that World Food Security is the common responsibility of the international community and gave the call that no child, women and man should go to bed hungry and no human being's physical and mental capabilities should be stunted by malnutrition. Since then the Food security has been a persistent issue raised in several national and international seminars and conferences organized during the last two decades. It has also found a prominent place in the research themes of scholars specially the geographers, economists and sociologists (Minhas, 1976; Sen, 1981; Radhakrishna, 1991; Tendulkar, et al., 1993; George, 1996; and Suryanaryana, 1996). The concept of food security is very complex, multidimensional and global, and it is being debated since last three decades (Mohammad, 2003).[2]

Food security as a global issue has been defined in a number of ways. It is to be interpreted as means for adequate availability of food items, particularly food grains. It also refers to the adequate purchasing power to meet the food requirement at household level (Sarkar, 2001).[3] Hence, a strategy for food security would encompass the essential components of food availability, with focus on those who are living below poverty line. Food security generally implies the physical supply of a minimum level of food grains during all periods including those of harvest failures (Reultinger, 1977). According to FAO (1984) the basic concept of food security implies that "all people at all times have both physical and economic access to the basic food they need". But the World Bank has modified it indicating, "food

security is access by all people at all times to enough food for an active and healthy life". Its essential elements are availability of food and the ability to acquire it (World Bank, 1986).

The most comprehensive and perhaps, largely accepted definition came out from the World Food Summit at Rome in 1996. "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". This definition emphasizes three basic dimensions of food security: (i) Availability of food means physical supply of desired food in sufficient quantity, (ii) Accessibility which implies an economic access indicating close link of purchasing power to food security, and (iii) Stability in supply which include access to global market (Bhattacharya, 2001,quated in Mohammad, 2003).[4]

Availability of enough food for all can be attained through efficient domestic production in each country and import of food from other countries. Appropriate use of natural resources can ensure universal food security sustainability. Stability can be ensured by taking appropriate pre-emptive steps, through which harmful seasonal and inter-annual instability of supplies can be reduced. Natural and man made disasters can often be anticipated or even prevented when they occur, can be timely effective and constructive. Accessibility to the adequate and safe food to all may be made possible by carefully taking into consideration the adequate income of people and sound governmental intervention and policies. The vast majority of malnourished do not have, at the first instance, adequate access to natural resources, jobs, income or social security (Chaturvedi, 1997[5] and Ghosh, 2000).[6]

The term 'food security' has been derived from the Latin word 'secure', means free from care and anxiety and hence, implies not only access but also right to food or freedom from hunger. The United Nations has legitimately considered the access of around 826 million hungry people of the developing world to adequate food as a Universal Human Right and collective responsibility of the world community. The universal declaration of Human Rights (1948), and the International Convention of Economic, Social and

Cultural Rights (1966), recognized that to be free from hunger is a fundamental right of every one (Halim,B.,2002).[7]

There is a considerable imbalance between the food consumption and domestic production of food in developing countries, and the call for food security aims to minimize this gap through the short term and long term measures. The problem has a short-term dimension due to inter–year fluctuations in food supplies. It can be measured by short-term variability in food grain availability, while the problem has a long-term dimension and it is the growing import needs of less developed countries. Import increased from 52 million tones, in 1972 to over 70 million tones in 1978 [Green and Kirkpatrick, 1982]. A major feature of the global food security scenario is that marked imbalances exist across regions. Nearly, 80 per cent of world population live in the developing countries, these countries, put together, produce only 59 million tones of the world's cereal production while developed countries had a surplus of 92 million metric tones during the 1985–86. This imbalance between food and population compels the developing countries to import the surplus of the developed countries through commercial purchase, bilateral arrangement and through multilateral aid. The situation would become grimmer in coming years, in view of the fact that there is a recent trend of decrease in cereals production in the developing countries. During 1970–85, the annual growth rate of food production was 3.8 per cent, which dwindled to 2.8 per cent in subsequent years. This means increase of food import to avert famine. But many deficit countries are not in a position to import foodgrains because of their inability to pay for it (Banerjee, 1997).[8]

The concept of food security cannot be restricted to the boundaries of a country alone, it is a global concept. Hunger and deprivation in any part of the world are totally incompatible with the food security concept of the modern world. No region of the world is totally free from scarcities and failure of crops, but on the world-wide basis the surplus of one region would go a long way in meeting the deficit of others. In chronic deficit countries, however, domestic production may not be adequate to sustain the necessary reserves and in their case the stocks could be built through imports alone. Such deficit

countries are generally short of foreign exchange to finance the import bill and they will need the assistance of the surplus countries as also of the international financial institutions for building up their reserve and the infrastructure needed for it. It is in this sense that the concept of food security is global (Acharya, 1983).[9]

The concept of food security is the management of food economy in a manner that society does not depend on external assistance to meet the normal cyclical shortage that occurs in the agricultural economy. In situation of exception, misfortunes and when the calamity persists for more than one year, it would be obvious that resources would be slender to combat the misfortune and assistance from friendly countries would be essential. This mutual give and take is obligatory, if the lessons of the human civilization are not to be ignored. Nevertheless, it is equally important that help from outside countries collective would be possible only when the philosophy of food security is adopted by every country (Acharya, 1983)[10].

In theory, self-sufficiency of a state is not crucial because inter-state movement of food should make it possible to transport it to deficit states. Nonetheless, in practice, adequate production at the state level is important because it facilitates consumption, particularly in rural areas and by the poor (Srivastava, 2000).[11]

Food security means not only the availability of food for direct consumption, but it also has other implications. The fact is that the world now produces enough food; capable of feeding every stomach does not solve the problem. It is a question of not only production but distribution or attacking the underlying factors that cause hunger. The issue is further compounded by regional disparities and most importantly, individual families or intra-household food situation. Even within a household, women face the brunt of chronic malnutrition as they are affected by age old gender discrimination (Ghosh, 2000).[12]

Distribution efficient and of the right type is also integral part of food security system. Availability of stocks with government will be of little use if they cannot be supplied to the people who need them and at the right time.

Indeed there have been instances when absence of a proper distribution system led to large-scale f3ood crisis despite availability of stocks. It would be no exaggeration to say that the distribution system takes care of a very large part of the food security concept. It is the art of managing scarcities and shortages, which is the central feature of food security system of a country. Availability of food grains will have little relevance if people do not possess purchasing power to buy them for their consumption. This compulsion casts a responsibility on the government to device ways and means by which, in the first instance, food is available within the country and in the second, people have means to purchase or access food through employment generation schemes dovetailed with development programmes on a fairly continuing basis. (Acharya, 1983).[13]

Stability in food price is important specially for the poor, who spend a large part of their income on food, when food prices increase, many who are in the margin of the poverty line get pushed down.

Indian food policy has two important objectives; first to stabilize food grain supplies and prices overtime through stock policies and second, to make foodgrains more evenly available across regions to stabilize prices by procuring grains from surplus areas and supplying them in deficit areas. Accordingly, food grain markets in India have faced several interventions including controls on private storage and movement through policies such as the Essential Commodities Act and Zoning that prohibits private trade in foodgrains across broad zones. Private agents buy grains at low prices in peak seasons or from surplus areas and sell them when prices are high during the lean season or in deficit areas thereby lifting up the prices. Food price stability and food security can thus be promoted if this is restriction on private storage and trading activities. Although, serious efforts have been made in the recent past to improve food supply to the poor by way of introducing the Targeted Public Distribution System (TPDS). In the wake of economic reforms, the PDS is perceived as the main safety net to protect the poor from potential short–run price induced adverse effects of economic reforms (Radhakrishna, 2002).[14] In India, a large number of fair price shops are developed, where the grains are supplied out of the stocks procured by the

state at prices which are generally below the ruling market prices, i.e. at the minimum support prices. It is argued that though the system is meant to meet the requirements of the poor, in effect it is taken advantage of by the 'not-so-poor.' It is also contended that the cost incurred on the PDS is unjustifiably high. There is force in both these comments. However, the alternative is not to abandon the system, but to ensure that proper targeting is done, and the distribution costs are controlled. For realizing these objectives the involvement of the local level institutions can be extremely helpful. In our country such involvement could now be facilitated with the establishment of the Panchayati Raj System.

The concept of food security has undergone considerable modifications in the recent years. Food availability and stability are considered good measures of food security till the seventies, and the achievement of self-sufficiency was accorded high priority in the food policies of developing countries. However, though some countries were successful in achieving self-sufficiency by increasing their food production and also improved their capacity to cope with year-to-year fluctuations in production, they could not solve the problem of chronic household food insecurity.

This necessitated a change in approach and as a result the food energy intake of vulnerable groups is now given prominence in assessing food security. It has become common practice to estimate the number of food insecure households by comparing their calorie intake with the required norms. However, the widely accepted norms of the level of calorie intake required for overcoming under-nutrition have been questioned. Nutritionists argue that energy intake is a poor measure of nutritional status, which depends on not only the nutrient intake but also non-nutrient food attributes, privately and publicly, provided inputs, and health status. The non-food factors, which influence biological absorption, are also considered important for food security.

It is suggested that the assessment of malnutrition should be based on outcome measures rather than input measures. The suggested 'outcome measures' include anthropometric measures, clinical signs of malnutrition, biochemical indicators and physical activity. Among these, anthropometric

measures are considered to have an advantage over other indicators since body measurements are sensitive to even minor levels of malnutrition whereas biochemical and clinical indicators are useful only when the level of malnutrition is extreme. Outcome indicators are also more closely related to health and functional capacity.

REFERENCES

1. FAO (1974): The World Food Conference in 1974, United Nations.
2. Mohammad, N. (2003): Spatial Inequality in Food Security in Rural India, *The Geographer*, Vol. 50, No.1, p.44.
3. Sarkar, A. N. (2001): National Food Security Perspectives with a Global Vision, *Indian Farming*, Vol. 50, No. 10, p.30.
4. Bhattachariya, B., (2001): *Food Security* quoted in Mohammad, N., Spatial Inequality in Food Security in Rural India, (2003), *The Geographer*, Vol. 50, No.1, pp.44-45.
5. Chaturvedi R. (1997): Food Security and Panchayati Raj System in India, Concept Publication., New Delhi, pp.267-268.
6. Ghosh, G.N. (2000): Food Insecurity, The Greatest Challenge of the Millennium, *Indian Farming*, Vol. 50, No. 7, p. 7.
7. Halim, B. (2002): *Right to Food: The Peoples Perspective* in Chaturvedi, P. (ed.), Food Security in South Asia, Concept Publishing Company, New Delhi.
8. Banerjee, B. (1997): Population Explosion, Food Security and Sustainable Development, *Geographical Review of India,* Vol. 59, No. 1, pp. 4-5.
9. Acharya, K.C.S. (1983): Food Security System of India, Concept Publishing Company, New Delhi, pp.2-3.
10. Acharya, K.C.S., 1983, ibid, p.2.
11. Srivastava ,N. (2000): *The Paradox of Food Insecurity in a Food Surplus State: The Case of Uttar Pradesh* in Dev ,S.M and et.al.(eds), Towards a Food Secure India ,Issues and Policies, Published By Institute For Human Development, New Delhi, p.255.
12. Ghosh ,G.N.,2000,op.cit., p.7
13. Acharya, K.C.S., 1983, op.cit, pp.2-3.
14. Radhakrishna,R. (2002) :Food and Nutrition Security in Parikh ,S. and Radhakrishna ,R. (eds) *Indian Development Report,* Oxford University Press, p.51

Chapter III

TECHNOLOGICAL AND INSTITUTIONAL FACTORS AFFECTING AGRICULTURE

The agricultural development of a country or a region to a large extent depends on a large number of technological and institutional factors. These factors consist of irrigation, use of chemical fertilizers, insecticides, pesticides, high yielding varieties of seeds, application of modern agricultural implements and machineries, agricultural loans, size of land holdings etc. Variations in agricultural development may be due to variations in any or all of these indicators over time and space.

The new agricultural technology has played a significant role not only in minimizing the risk from environmental constraints but also has augmented the yield levels of the crops. A series of methods have been evolved to increase productivity by using fertilizers and better techniques. The speedy and substantial development of agriculture by and large depends on bringing technological change and spatial diffusion of agricultural innovations (Mohammad, 1981)[1]. Increase in the cultivated area as well as yield are often due to technological improvements.

Indian agriculture has experienced a significant break through during the last five decades. Both production and yield levels have increased considerably after introduction of new agricultural technology. In North Bihar Plain, there has been a slow and inadequate application of technology in agricultural production. The productivity of the farm lands is now improving due to recent adoption of modern agricultural inputs and the state government has also taken various measures to make available these inputs across the states.

In order to assess the situation of technological and institutional factors the indicators like percentage of net irrigated area to the total cropped area (source wise), percentage of area under High Yielding Varieties (HYV) of seeds to the total cropped area, use of fertilizers in kg. per hectare, number of pumpsets and tractors per 10,000 hectares, amount of agricultural loans in

Rs. per 1,000 hectares of cropped area have been selected and analyzed for each district.

IRRIGATION

Irrigation means the artificial application of water to overcome the deficiency in rainfall for growing crops (Contor, 1967).[2] Agriculture without irrigation is limited and if the rainfall decrease to less than 30cm. cultivation of crops becomes impossible without irrigation (King, 1953).[3] Irrigation is one of the most significant agricultural inputs on which success of other inputs depends. The spread of new technology, particularly the high yielding varieties of seeds and use of fertilizers are conditioned by the availability of water. It may not be appropriate to leave agriculture to the vagaries of monsoon. In monsoon lands like India, where the rainfall and its distribution shows wide variations, irrigation facilities are essential for achieving assured and high level of agricultural production. In areas where rainfall is plentiful and well distributed there is no problem of water. But some areas experience very erratic and uncertain rainfall. Therefore, in such areas assured irrigation is undoubtedly essential. The creation of irrigation facilities not only induces farmers to change their cropping pattern by substituting high value crops in place of low value crops and replacing traditional varieties by new ones, but it also helps for intensive use of inputs to maximize the agricultural productivity.

Being a part of the monsoon region, the rainfall regime in North Bihar Plain is characterized by uncertainty and irregularity, and it is often inadequate during the period of crops growth and does not fulfill the crops requirement. Under these circumstances, therefore, assured means of irrigation becomes essential for sustaining the growth of crops.

The requirement of irrigation can be fulfilled by two different sources: (i) Irrigating the land by taping sub-soil water with the construction of wells, tube-wells and pump-sets and (ii) By distributing the surface water through canals, tanks and ponds. In the study area the main sources of irrigation are canals, tube -wells, wells and ponds. The district wise respective share of each

Table 3.1 Sourcewise Irrigation in Districts of North Bihar Plain 2000-2001

Sr. No.	Districts	Canal	Tube-wells	Other sources	Net irrigated area to the total cropped area
		(in percentage)			
1	Saran	16.51	68.81	15.59	52.91
2	Siwan	19.85	73.81	6.87	75.65
3	Gopalganj	41.88	58.72	0.00	68.94
4	East Champaran	9.62	85.90	4.48	48.62
5	West Champaran	58.21	23.88	7.46	48.60
6	Muzaffarpur	1.87	93.91	4.32	49.05
7	Vaishali	0.00	84.72	15.58	58.33
8	Sitamarhi	1.56	79.69	18.75	30.06
9	Darbhanga	0.00	16.92	83.08	40.83
10	Madhubani	6.67	36.00	57.33	31.09
11	Samastipur	0.00	95.40	0.00	42.30
12	Begusarai	0.00	89.41	10.59	68.49
13	Bhagalpur	7.69	62.82	29.49	48.61
14	Saharsa	28.00	65.33	6.67	65.00
15	Purnia	21.43	66.35	11.22	31.46
16	Katihar	11.25	88.75	0.00	39.02
17	Madhepura	51.52	37.37	11.11	75.21
18	Khagaria	0.00	83.64	16.36	55.31
19	Supaul	51.49	46.53	1.98	61.50
20	Araria	19.05	66.67	14.28	33.11
21	Kishenganj	0.00	89.47	0.00	13.64
22	Sheohar	0.00	81.82	18.18	36.40
North Bihar Plain		**19.05**	**67.27**	**13.67**	**19.33**

Source:Official Records of Directorate of Statistics and Evaluation, Bihar Patna.

Note:Other Sources Includes Tanks, Ponds, Other wells.

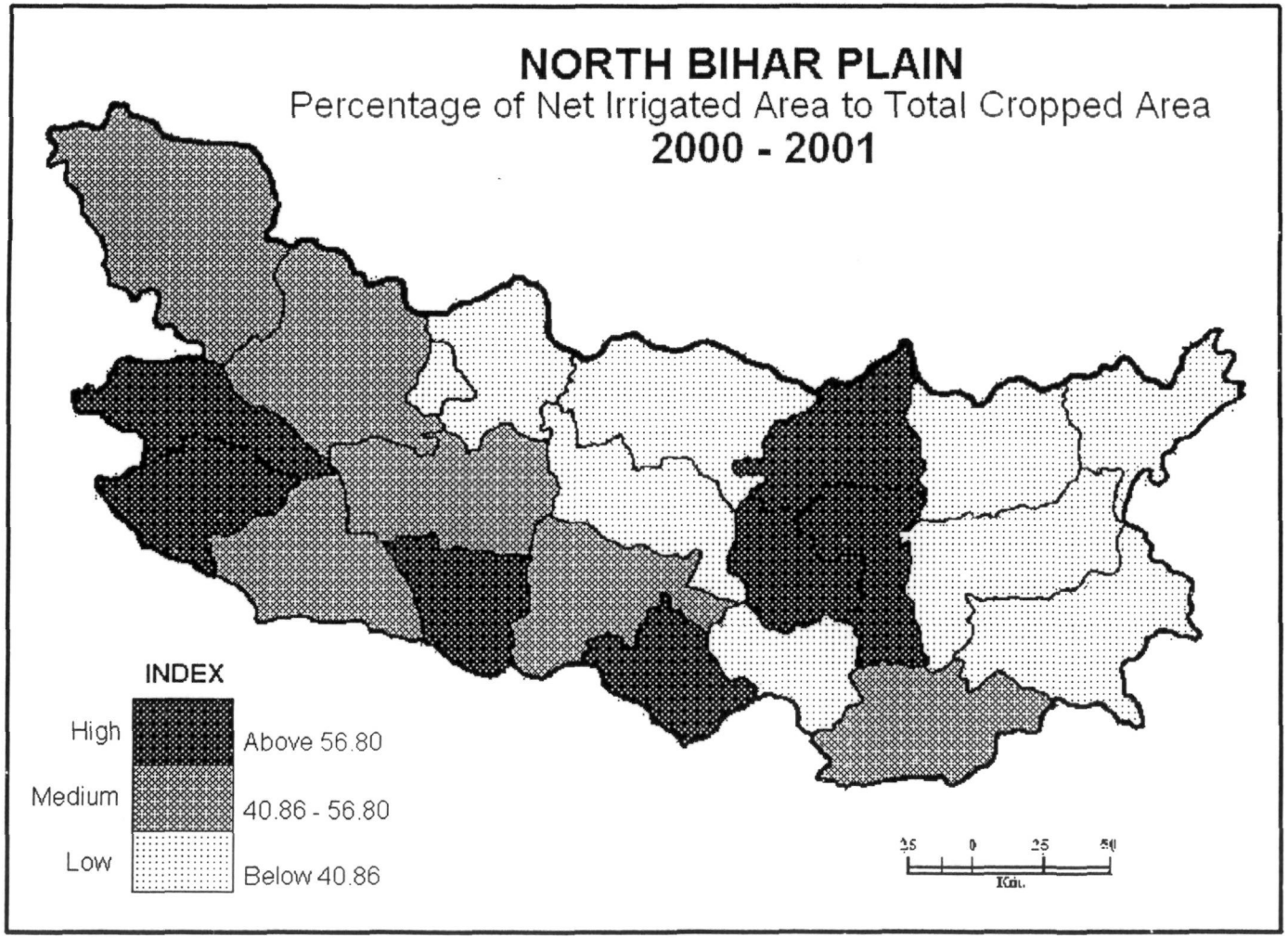

NORTH BIHAR PLAIN
Percentage of Net Irrigated Area to Total Cropped Area
2000 - 2001
INDEX
High
Above 56.80
Medium
40.86 - 56.80
Low
Below 40.86
25 0 25 50
Km.

Fig.3.1

source in North Bihar Plain is shown in Table 3.1. It may be seen from the table that tube-wells alone provided irrigation to the extent of about 67.27 per cent of the net irrigated area. Next to tube-wells, canal irrigation occupies second position providing irrigation to more than 30 per cent of the net irrigated area.

In order to show the regional pattern of irrigation facilities from different sources all districts have been categorized under three broad groups. The districts having more than 56.80 per cent of total cropped area under irrigation fall into high irrigation availability. The districts grouped between 40.86 and 56.80 per cent are considered as of medium irrigation availability, while the districts with less than 40.86 per cent are placed under low availability of irrigation.

It may be seen in the Fig. 3.1 that the area under high availability of irrigation is spread over the districts of Siwan, Gopalganj, Vaishali, Begusarai, Saharsa, Madhepura, and Supaul. Medium irrigation is recorded in the districts of East and West Champaran, Saran, Muzaffarpur, Samastipur and Bhagalpur. Low irrigation region is spread over the districts of Purnia, Araria, Kishenganj and Sitamarhi, Darbhanga, Madhubani, Katihar, Khagaria and Sheohar.

I.Canal Irrigation

There are many canals which provide irrigation in North Bihar Plain, but the important ones are the Tribeni canal and Western Kosi canal. Tribeni canal takes its water from the left bank of the river Gandak at Tribeni (Bhaisa Lotan). The Western Kosi canal lies in the western part of the river Kosi. It is evident from the Table 3.1 that irrigation by canal is important and extensive in West Champaran, Gopalganj, Madhepura, Saharsa and Supaul where more than 50 per cent of the total irrigated area receives water from them, where net irrigated area is reported above 24.86 per cent. Medium irrigation spread is seen in the districts of Saran, Siwan, East Champaran, Purnia, Katihar and Araria with 7.41 to 24.86 per cent. The districts of Muzaffarpur, Sitamarhi, Madhubani and Bhagalpur have less than 7.41 per cent of the total cropped

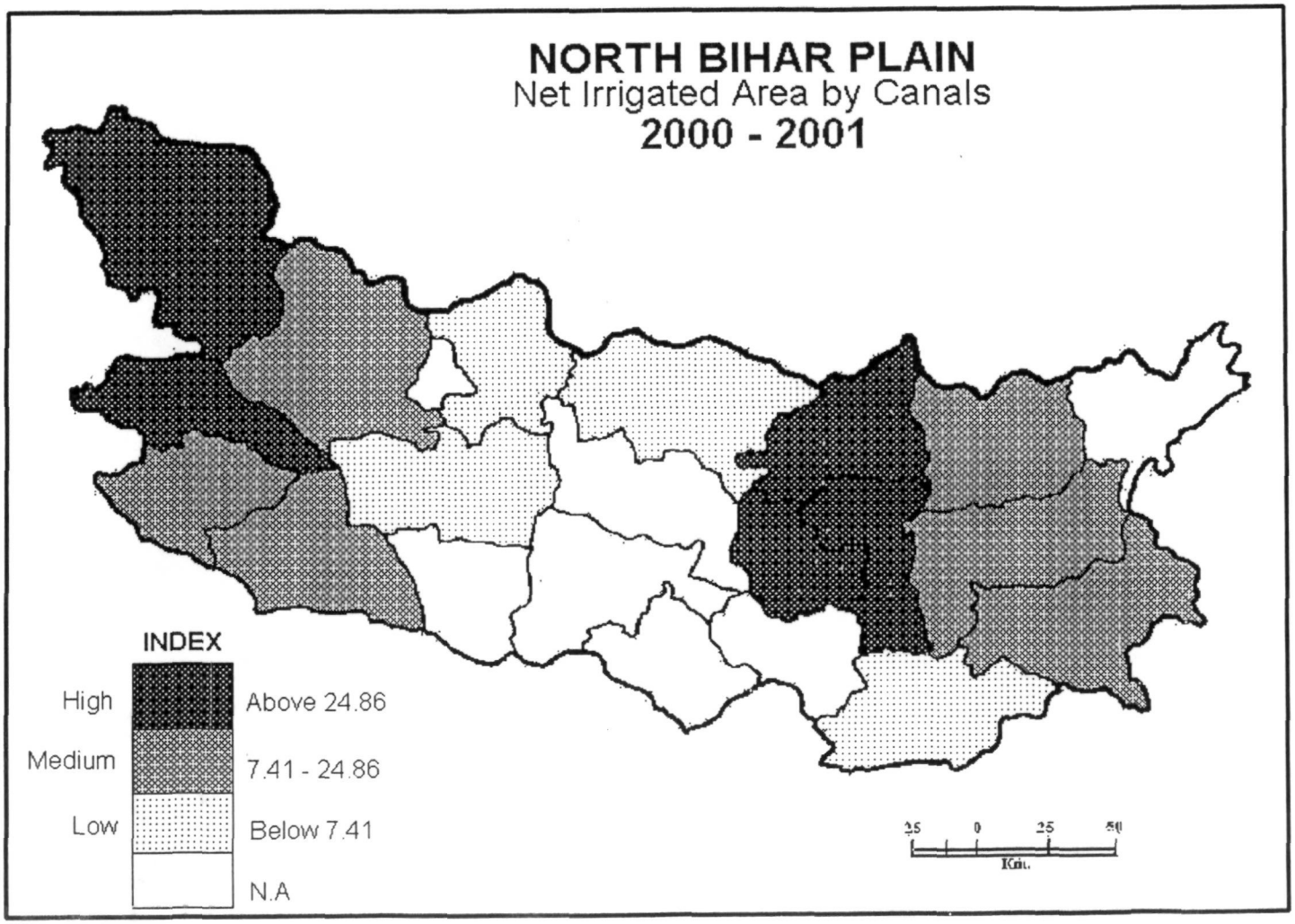

NORTH BIHAR PLAIN
Net Irrigated Area by Canals
2000 - 2001
INDEX
High
Above 24.86
Medium
7.41 - 24.86
Low
Below 7.41
N.A
25 0 25 50
Km.

Fig.3.2

area irrigated by canals. Canal irrigation is insignificant in seven districts namely, Vaishali, Samastipur, Darbhanga, Begusarai, Khagaria, Kishenganj and Sheohar.

II. Tube-well Irrigation

Tube-well irrigation is relatively of recent origin in India and the rate of its adoption in different parts of the country is very fast. It is very important in the study area which is a part of Indo-Gangetic plains and where sub-soil water resource occurs in abundance and available at shallow depth. The importance of tube-well irrigation over canals lies because of the fact that the tube-well can be dug right in the vicinity of farm, where water is needed.

The net irrigated area by tube-wells in the North Bihar Plain accounts for 67.27 per cent of the total irrigated area in 2000-2001. It is more extensive in Sitamarhi, Sheohar, Muzaffarpur, Vaishali, Samastipur, Begusarai, Khagaria, Katihar and Kishenganj and is reported above 80.40 per cent. There are eight districts of medium category namely, East Champaran, Gopalganj, Siwan, Saran, Saharsa, Araria, Purnia and Bhagalpur. The low irrigated area by tube-well is spread in four districts namely, West Champaran, Madhubani, Darbhanga, Supaul and Madhepura which receive a share with less than 57.09 per cent of irrigated area by tube-wells.

III. Irrigation by other sources

Those areas, where irrigation by canals and tube-wells are not available, irrigation is provided from other sources. The other sources include tanks, ponds and wells which altogether accounts for 13.67 per cent of the total irrigated area during 2000-2001. Fig. 3.4 shows that three districts namely, Darbhanga, Madhubani and Bhagalpur where net irrigated area by other sources is more than 24.18 per cent. The districts of West Champaran, Siwan, Saran, Vaishali, Begusarai, Khagaria, Saharsa, Madhepura, Araria and Purnia are found in the category of medium irrigation (5.96-24.18 per cent) by other sources. The low irrigated area by other sources is recorded in three districts namely, East Champaran, Muzaffarpur, Supaul with less than 5.96

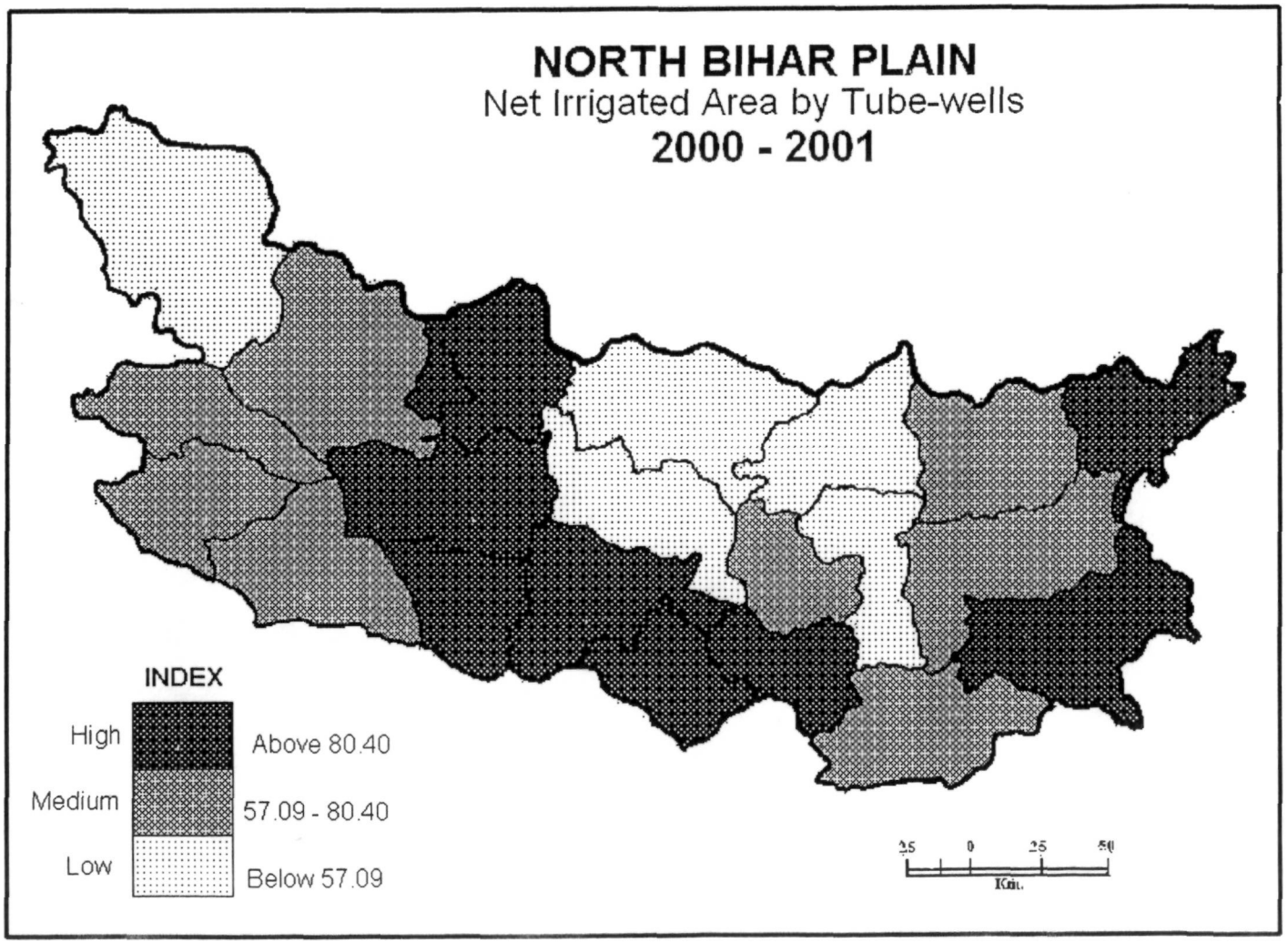

NORTH BIHAR PLAIN
Net Irrigated Area by Tube-wells
2000 - 2001
INDEX
High
Above 80.40
Medium
57.09 - 80.40
Low
Below 57.09
25 0 25 50
Km.

Fig.3.3

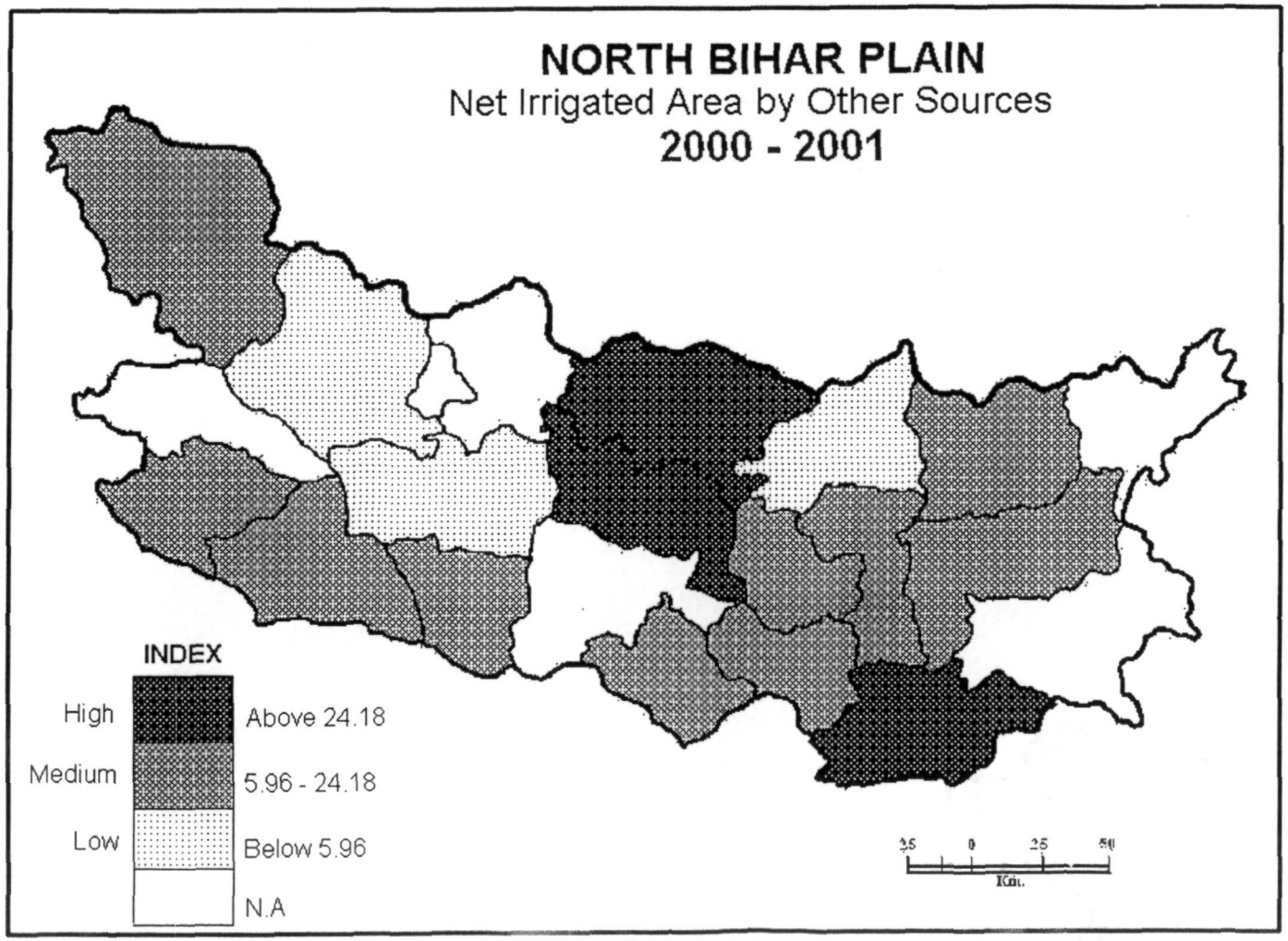

NORTH BIHAR PLAIN
Net Irrigated Area by Other Sources
2000 - 2001
INDEX
High
Above 24.18
Medium
5.96 - 24.18
Low
Below 5.96
N.A
25 0 25 50
Km.

Fig.3.4

per cent. The districts namely Gopalganj, Sitamarhi, Sheohar, Samastipur, Katihar and Kishenganj did not record irrigation by these sources.

HIGH YIELDING VARIETIES OF SEEDS

High yielding varieties of seeds plays a vital role in increasing the agricultural productivity and paving the way for the success of green revolution. The success of the high yielding varieties programmes has revolutionized Indian agriculture and brought out a phenomenal and rapid increase in food grains production in the country. The North Bihar Plain has not been an exception from its impact and farmers have been using new varieties of seeds for the production of different crops but at a slow rate.

Table 3.2 shows districtwise distribution of high-yielding varieties of seeds in North Bihar Plain during 2000-2001 on which Fig. 3.5 is based, in which all 22 districts have been categorized under three distinct groups i.e., high, medium and low. It can be seen from the figure that there are seven districts namely, West Champaran, East Champaran, Gopalganj, Siwan, Saran, Khagaria and Bhagalpur which records above 96.05 per cent of their cropped area under high yielding varieties of seeds. The use of high yielding varieties of seeds is well adopted by majority of the farmers of western part of the North Bihar Plain. The districts under the medium grade of the use of improved seeds are Muzaffarpur, Samastipur, Darbhanga, Begusarai, Madhubani, Supaul, Madhepura, Saharsa and Katihar. These districts have devoted 92.58 to 96.05 per cent of their cropped area to the high yielding varieties of seeds. The districts lying in low percentage of area under high yielding varieties of seeds are Sitamarhi, Vaishali, Purnia, Araria and Kishenganj which records below 92.58.

CHEMICAL FERTILIZERS

Use of chemical fertilizer is recognized as one of the quickest ways in boosting agricultural production. The importance of fertilizers has been well appreciated by cultivators as well as others who are concerned with the agricultural production. The provision of fertilizers availability at reasonable

Table 3.2 Districtwise area under High-Yielding Varieties of Seeds in North Bihar Plain 2000-2001

Sr. No.	Districts	Area under HYV of Seeds (per cent to the total cropped area)
1	Saran	97.07
2	Siwan	97.35
3	Gopalganj	96.72
4	East Champaran	98.50
5	West Champaran	98.00
6	Muzaffarpur	95.52
7	Vaishali	90.25
8	Sitamarhi	87.34
9	Darbhanga	94.78
10	Madhubani	93.23
11	Samastipur	95.73
12	Begusarai	94.67
13	Bhagalpur	96.75
14	Saharsa	93.47
15	Purnia	92.50
16	Katihar	94.97
17	Madhepura	94.46
18	Khagaria	98.80
19	Supaul	93.82
20	Araria	90.01
21	Kishenganj	84.76
22	Sheohar	94.87
North Bihar Plain		**94.25**

Source: Official Records of Directorate of Statistics and Evaluation, Bihar, Patna.

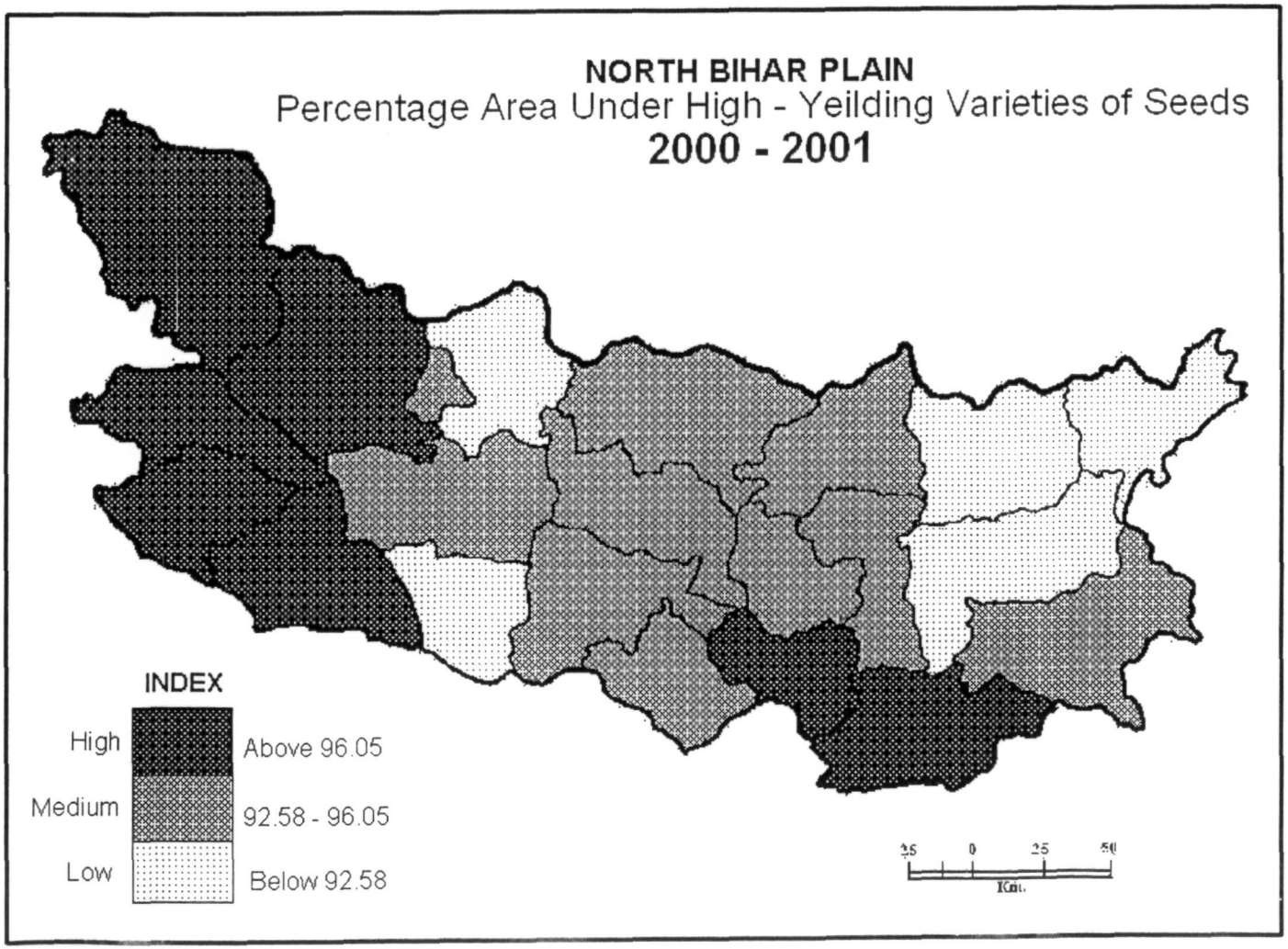

NORTH BIHAR PLAIN
Percentage Area Under High - Yeilding Varieties of Seeds
2000 - 2001
INDEX
High
Above 96.05
Medium
92.58 - 96.05
Low
Below 92.58
25 0 25 50
Km.

Fig.3.5

Table 3.3 Districtwise Consumption of Fertilizers in North Bihar Plain 2000-2001

Sr. No.	Districts	NPK (in kg. per hectare)
1	Saran	131.21
2	Siwan	75.33
3	Gopalganj	72.07
4	East Champaran	121.11
5	West Champaran	136.29
6	Muzaffarpur	184.28
7	Vaishali	93.61
8	Sitamarhi	137.72
9	Darbhanga	163.82
10	Madhubani	86.71
11	Samastipur	85.01
12	Begusarai	293.95
13	Bhagalpur	168.45
14	Saharsa	91.41
15	Purnia	116.16
16	Katihar	53.24
17	Madhepura	134.38
18	Khagaria	266.09
19	Supaul	43.53
20	Araria	95.71
21	Kishenganj	38.28
22	Sheohar	26.14
North Bihar Plain		**118.84**

Source: Official Records of Directorate of Statistics and Evaluation, Bihar, Patna.

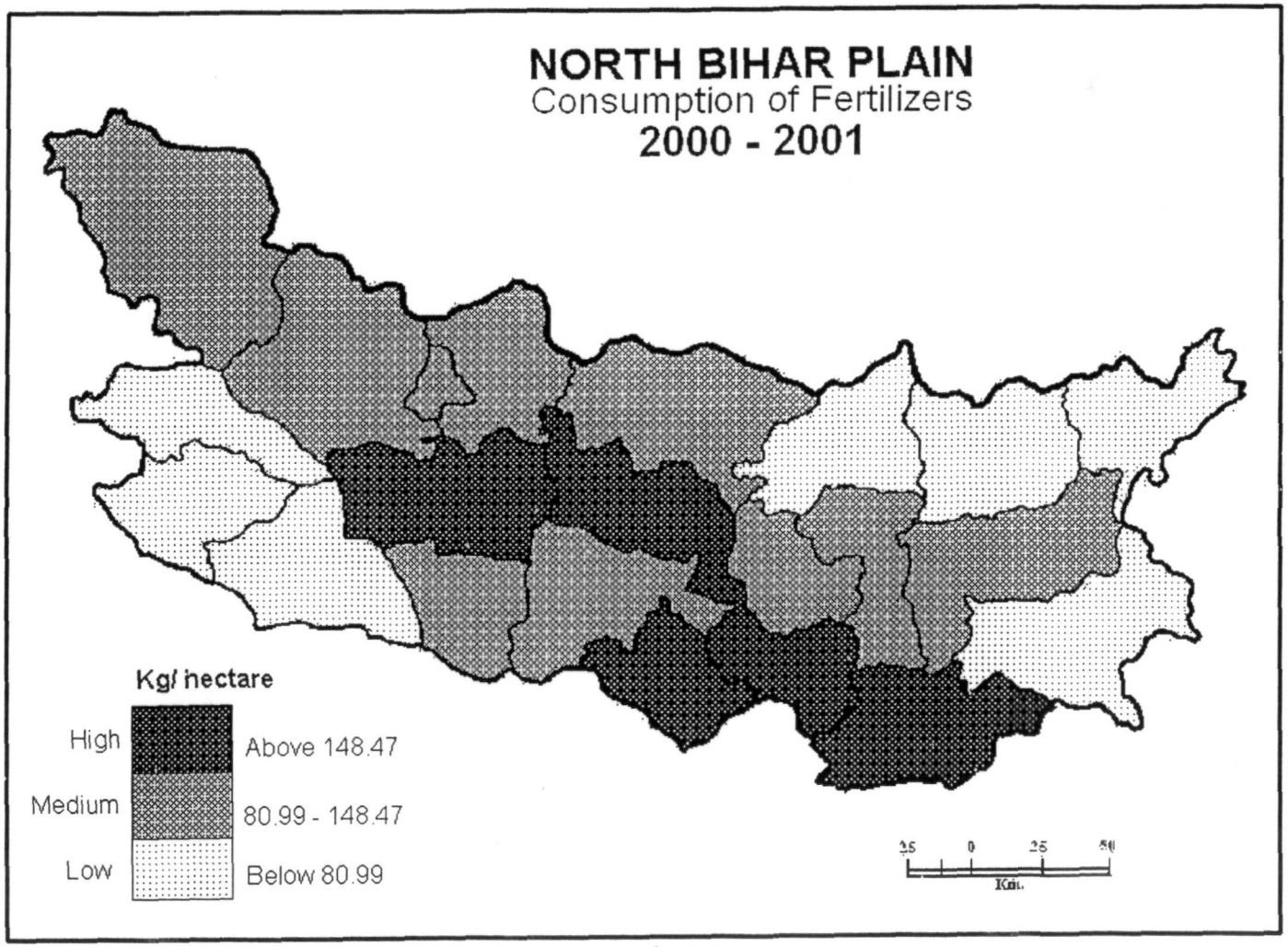

NORTH BIHAR PLAIN
Consumption of Fertilizers
2000 - 2001
Kg/ hectare
High
Above 148.47
Medium
80.99 - 148.47
Low
Below 80.99
25 0 25 50
Km.

Fig.3.6

costs, and at appropriate time is an essential requirement for the growth of crops (Champa, 1976).[4] In a study done in USA,it was found that fertilizers constituted the largest single factor in increasing crop production and accounted for 50 per cent of yields. A series of trials conducted by Food and Agricultural Organization of the United Nations in 14 different countries in the world have established beyond any doubt that substantial increases in the yield of crops can be obtained by the use of fertilizers, even if, no other technological factor is changed (Chaudhary,1974).[5]

The findings of First Five Year Plan pointed out that under conditions prevalent in India, fertilizers are responsible for an increase of about 45 per cent in agricultural production. In view of their overwhelming impact on crop production it is considered to evaluate the consumption levels of fertilizers in North Bihar Plain. Although, there are variations in the consumption levels of fertilizers in different districts of the study area, yet some of them show a satisfactory level of fertilizers consumption.

Fig. 3.6 shows spatial pattern of fertilizers consumption at district level. It is apparent from the figure that there are five districts namely, Muzzafarpur, Darbhanga, Begusarai, Bhagalpura and Khagaria, in which farmers are well aware about the importance of fertilizer and its applications. These districts record consumption of fertilizer above 148.47 kg per hectare. Medium consumption of fertilizers is found in East Champaran, West Champaran, Saran, Vaishali, Sitamarhi, Madhubani, Samastipur, Saharsa, Purnia, Madhepura and Araria. The fertilizers use in these districts ranges between 80.99 to 148.47 kg per hectare. The remaining districts namely, Siwan, Gopalganj, Katihar, Supaul, Kishenganj and Araria record low levels of fertilizers consumption less than 80.99 kg per hectare.

MECHANIZATION

Modern agricultural machines and tools also play a contributing role in increasing agricultural productivity as they save time and energy of farmers. In agricultural production process, a number of operations from preparation of seed bed to the final processing of products are to be performed by machines

Table 3.4 Districtwise Distribution of Agricultural Machinery in North Bihar Plain 2000-2001

Sr. No.	Districts	Tractors	Pumpsets
		(Nos. per 10,000 ha)	
1	Saran	29	629
2	Siwan	40	635
3	Gopalganj	69	339
4	East Champaran	52	169
5	West Champaran	109	158
6	Muzaffarpur	30	495
7	Vaishali	22	649
8	Sitamarhi	15	276
9	Darbhanga	29	385
10	Madhubani	14	180
11	Samastipur	22	401
12	Begusarai	59	304
13	Bhagalpur	39	169
14	Saharsa	24	181
15	Purnia	37	202
16	Katihar	28	394
17	Madhepura	15	174
18	Khagaria	29	398
19	Supaul	13	154
20	Araria	16	189
21	Kishenganj	14	175
22	Sheohar	13	276
North Bihar Plain		**32.63**	**315.09**

Source:Official Records of Directorate of Statistics and Evaluation, Bihar,Patna.

required to be to achieve the higher efficiency. Thus, in order to make agriculture productive and profitable, efficient and time saving devices should be brought in use to minimize the production cost as well as time required for agricultural operations.

It helps farmers by enabling them timely preparation of the ground, sowing, harvesting and threshing. The use of machinery depends on certain prerequisites of which size of fields occupies prominent position. Most of the farm machines such as tractors, harvesters and thresher are used profitably in large size fields but their efficiency suffers if the plots are small. Indian agriculture is characterized by small size of landholdings which stands hurdle in the way of mechanization. A large number of farmers are under the category of marginal farmers.

The agricultural machinery used in the study area for which data is available likes tractors and pumpsets and they are listed in Table 3.4. It is evident from the table that the use of farm machinery is not uniform and there are substantial variations in the level of farm mechanization in different parts of the region.

I. Tractors

In India about one million farmers have their own tractors and another three millions farmers depend on loaning facilities. Tractors are useful for various purposes such as ploughing fields, threshing crops, running pump sets, transporting agricultural produces and inputs etc. The availability of tractors in North Bihar Plain is shown in Fig. 3.7. It is apparent from the figure that highest concentration of tractors per 10,000 hectares of cropped land is found in West Champaran, East Champaran, Gopalganj and Begusarai. In these districts 43.85 tractors per 10,000 hectares of cropped land are found. The districts recording medium concentration of tractors are Siwan, Saran, Vaishali, Muzaffarpur, Darbhanga, Samastipur, Saharsa, Khagaria, Purnia, Katihar and Bhagalpur where its number ranges between 21.42 and 43.85 tractors per 10,000 of cropped area. Remaining seven districts namely, Sitamarhi, Sheohar, Madhubani, Supaul, Araria, Kishenganj and Madhepura

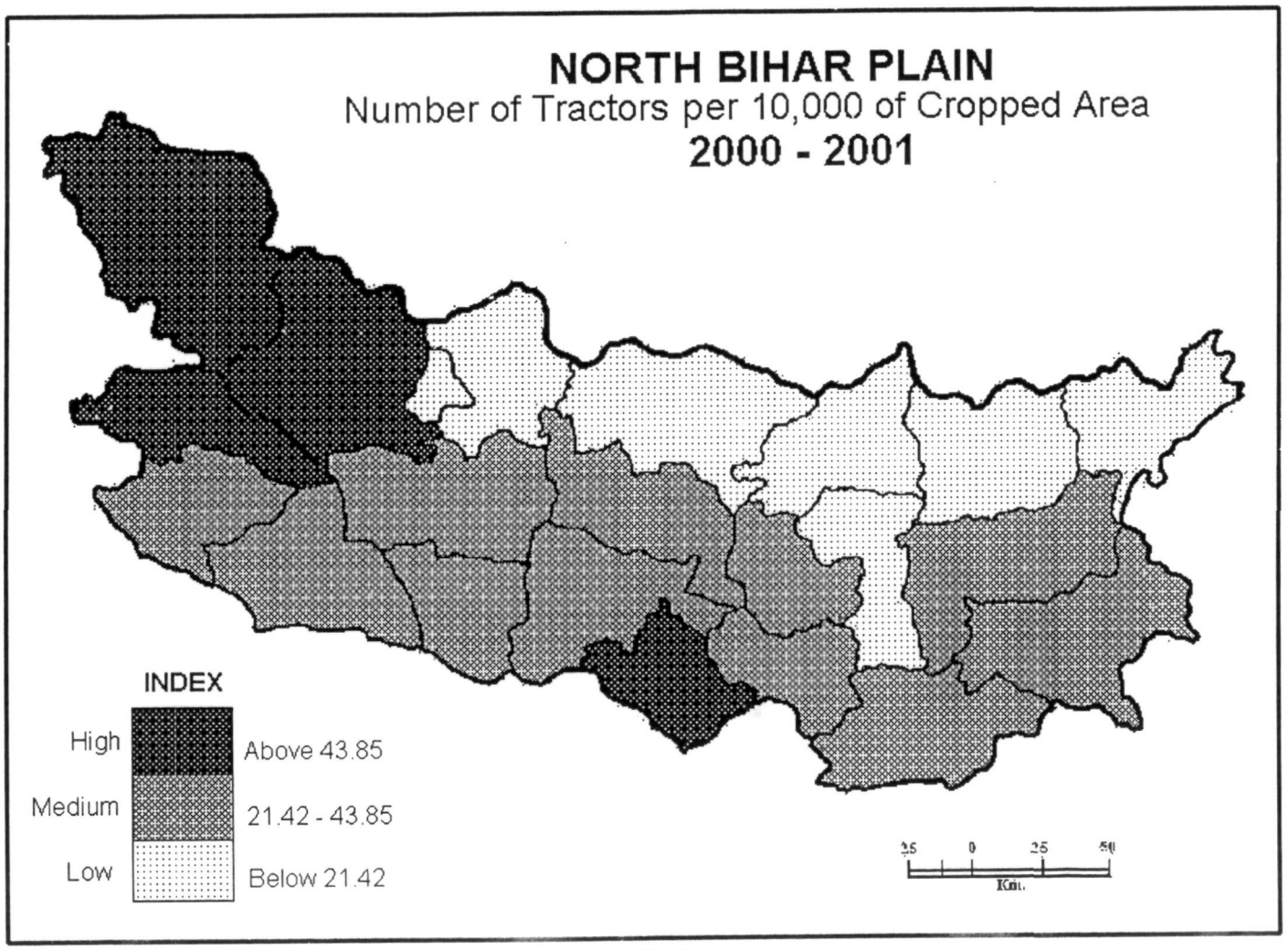

NORTH BIHAR PLAIN
Number of Tractors per 10,000 of Cropped Area
2000 - 2001
INDEX
High
Above 43.85
Medium
21.42 - 43.85
Low
Below 21.42
25
0
25
50
Km.

Fig.3.2

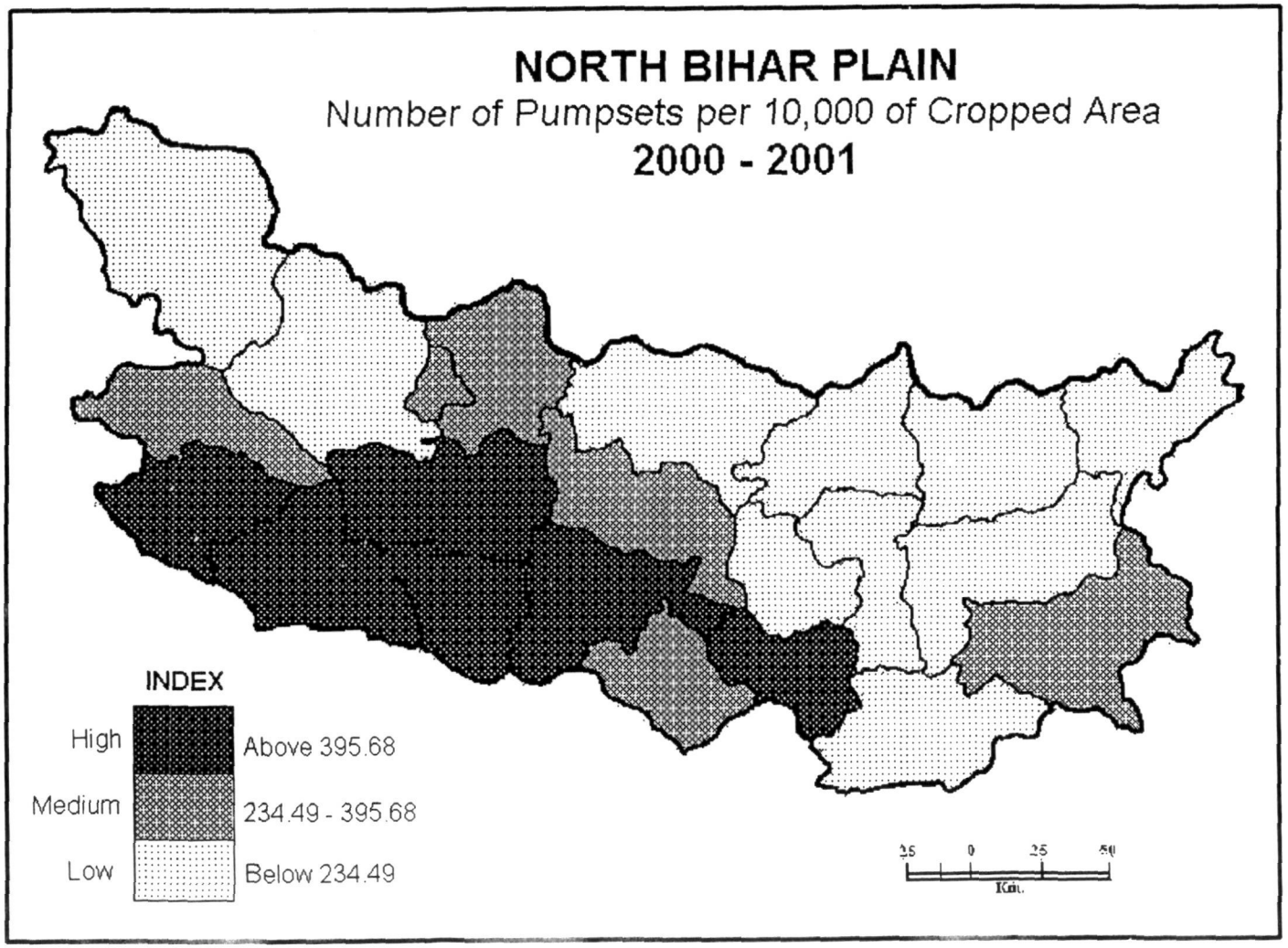

NORTH BIHAR PLAIN
Number of Pumpsets per 10,000 of Cropped Area
2000 - 2001
INDEX
High
Above 395.68
Medium
234.49 - 395.68
Low
Below 234.49
25 0 25 50
Km.

Fig.3.8

have very low concentration of less than 21.42 tractors per 10,000 hectares of cropped land, which lie in the northern part of the region.

II. Pumpsets

Pumpsets assume immense significance in the development of agriculture in India. It is used for driving tube- wells where electricity is not available or there is frequent problem of load shedding. The districtwise distribution of pumpsets for irrigation purposes in each district of the study area is shown in Fig. 3.8 which highlights that there are five districts namely, Saran, Siwan, Muzaffarpur, Samastipur and Vaishali with a compact block of high concentration of pumpsets used for irrigation in the south western parts of the study area. The district of Khagaria is also lying under the high concentration of pumpsets. In these districts the numbers of pumpsets are above 395.68 per 10,000 hectare of total cropped land. The medium concentration of pumpsets ranging from 234.49 to 395.68 per 10,000 hectares is observed in seven districts namely, Sitamarhi, Sheohar, Darbhanga, Begusarai, Bhagalpur, Gopalganj and Katihar. There is a compact region of low density of pumpsets in central eastern part of the study area which includes the districts of Madhubani, Supaul, Madhepura, Bhagalpur, Saharasa, Purnia, Araria and Kishenganj. The districts of West Champaran and East Champaran, are detached from the main region also fall under low density region and lies in northwestern part of the study area. The numbers of pumpsets used in these districts are below 234.49 per 10,000 hectares. It is clear that the concentration of pumpsets is low in the areas where canal and tube- wells constitute major sources of irrigation. On the other hand, in the districts where irrigation is provided by other sources, the use of pump sets is high.

COOPERATIVE BANKS

Cooperative Banks are regarded as the best agency to provide productive loans to the farmers for purchasing different agricultural inputs.[6] These banks are the basis of whole credit structure and finance for agrarian society. These banks also finance the village cooperative society.

Table 3.5 Loan Advanced by Cooperative Banks

Year	1980-1981	1990-1991	2000-2001
Agricultural credit advanced (Rs. In thousand)	30,792	35,39,530	13,922,580

Source: *Official Records of Registrar Cooperative Societies, Bihar,Patna.*

Table 3.5 shows the trend of loans advanced by cooperative banks in North Bihar Plain since 1980-81. The total amount of loans enhanced from Rs. 30, 792 in 1980-81 to Rs. 13,922,580 thousand crores in 2000-2001. The total increase of loan in the region was 129 per cent, giving an increase rate of 12.90 per cent per annum.

Table 3.6 shows districtwise short term loan distributed in North Bihar Plain. Agricultural credit has been shown in terms the indicator as agricultural credit per 1,000 hectares of cropped land. Actual distribution of agricultural loan per 1,000 hectares of cropped land in the eighteen districts of North Bihar Plain is depicted in Fig. 3.9. The data for districts i.e., Sheohar, Saharsa, Kishenganj and Supaul are not available and therefore position could not be shown on the map. It may be seen from the figure that the farmers in districts namely, Begusarai, Darbhanga and Khagaria have been highly benefited by this credit facility provided by cooperative societies and obtained the highest amount of loan in 2000-2001. Begusarai is placed at the top with Rs. 10, 38,290.85 followed by Darbhanga with Rs. 4, 08,346.56 and Khagaria with Rs. 3, 11,244.24 per 1,000 hectares of cropped land. In the medium category of credit facilities there are twelve districts namely, Gopalganj, Siwan, Saran, Vaishali, Samstipur, Sitamarhi, Madhubani, Madhepura, Purnia, Araria, Katihar and Bhagalpur, where farmers receive the loans ranging between Rs. 12,880.0 and 2,52,229.00 per 1,000 hectares. The districts of West Champaran, East Champaran and Muzaffarpur record low amount of agricultural loan.

Table 3.6 Districtwise Distribution of Agricultural Loan by Cooperative Banks in North Bihar Plain 2000-2001

Sr. No.	Districts	Agricultural loans (Rs. Per 1,000 hectares of cropped land)
1	Saran	80040.816
2	Siwan	77869.047
3	Gopalganj	617237.85
4	East Champaran	260491.80
5	West Champaran	41280.58
6	Muzaffarpur	137818.53
7	Vaishali	728773.58
8	Sitamarhi	630492.75
9	Darbhanga	4083465.61
10	Madhubani	63914.81
11	Samastipur	473199.20
12	Begusarai	10382908.50
13	Bhagalpur	2410088.24
14	Saharsa	NA
15	Purnia	2266846.40
16	Katihar	822404.76
17	Madhepura	724772.73
18	Khagaria	3112442.40
19	Supaul	NA
20	Araria	2266846.40
21	Kishenganj	NA
22	Sheohar	NA
North Bihar Plain		**20771.04**

Source: Official Records of Directorate of Statistics and Evaluation, Bihar, Patna.

Note: N.A-Data Not Available

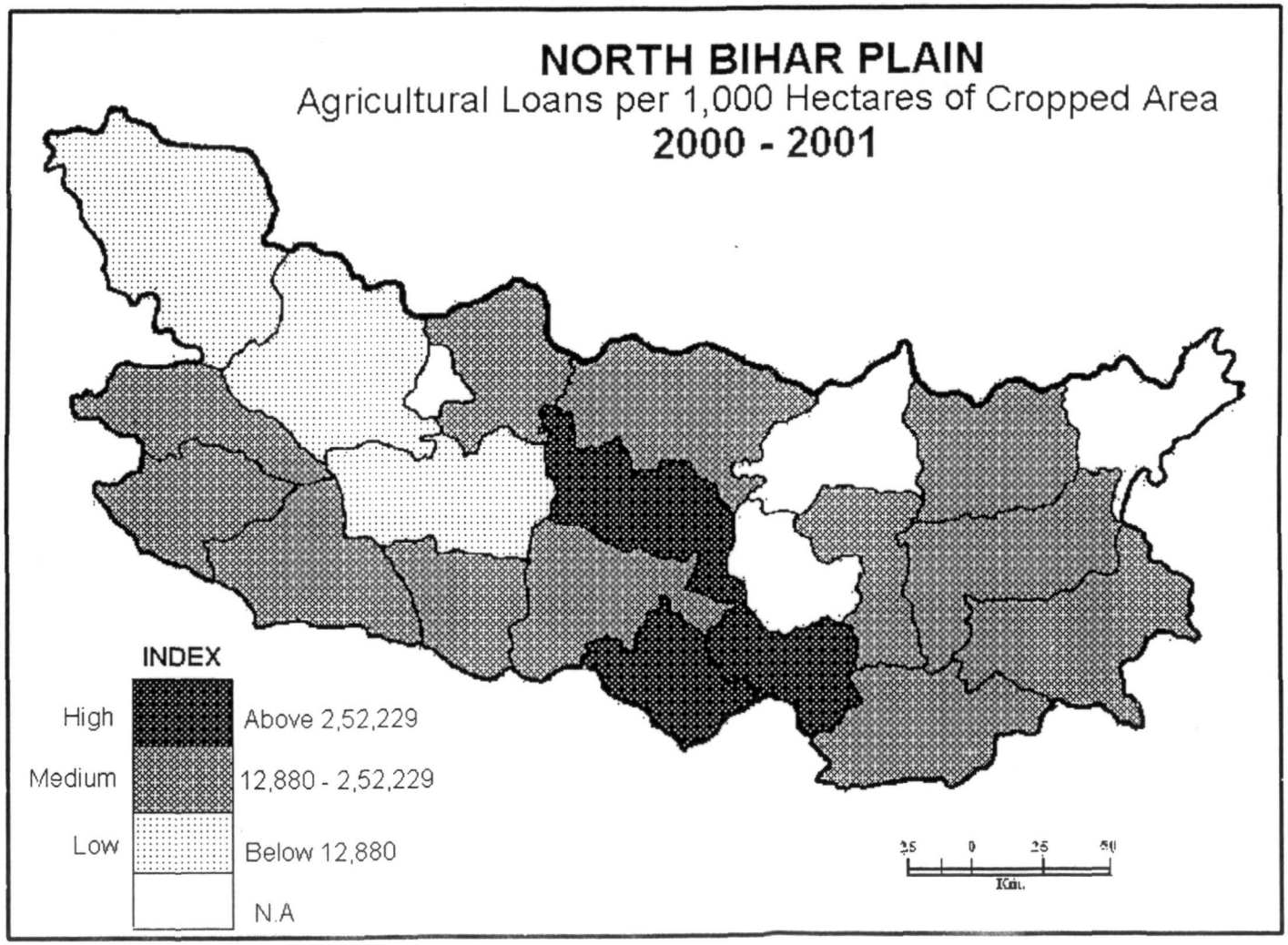

NORTH BIHAR PLAIN
Agricultural Loans per 1,000 Hectares of Cropped Area
2000 - 2001
INDEX
High
Above 2,52,229
Medium
12,880 - 2,52,229
Low
Below 12,880
N.A
25 0 25 50
Km.

Fig.3.9

COMPOSITE SCORES OF INDICATORS OF TECHNOLOGICAL AND INSTITUTIONAL FACTORS

The spatial diffusion of composite scores of technological and institutional factors in terms of the indicators, such as irrigation, consumtion of fertilizers, use of implements, high yielding varieties of seeds and agricultural loans has been measured (Table 3.7) and shown in Fig. 3.10.

High level of diffusion of technological and institutional factors is recorded in three districts namely, Saran, Siwan and Begusarai, which are located in the south north part of the study area.

Medium level of diffusion of technological and institutional factors is found in nine districts namely, West Chamaparan, East Chamaparan, Gopalganj, Muzaffarpur, Vaishali, Darbangha, Madhepura, Khagaria and Bhagalpur, which are mostly located in south eastern part of the study region.

Low level of technological and institutional factors is seen in the districts of Sitamarhi, Madhubani, Samastipur, Saharsa, Purnia, Katihar, Supaul, Araria, Kishenganj and Sheohar , which lies in eastern and central part of the North Bihar Plain.

From the above analyses, it may be concluded that the variation of level of agricultural technology is characterized by the variation in physico-cultural and socio-economic condition of the region, because it has direct impact on the diffusion of indicators of technological and institutional factors. The study area, which has adopted high level of technological and institutional factors, is characterized by high level of irrigation, agricultural loans, high literacy rate and use of higher amount of HYV of seeds and social awareness.

Table 3.7 Z-scores of Indicators of Technological and Institutional Factors in North Bihar Plain 2000-2001

Sr. No.	Districts	'Z' Score indices of HYV	'Z' Score indices of Fertilizers	'Z' Score indices of Tractors	'Z' Score indices of Pumpsets	'Z' Score indices of NIA	'Z' Score indices of Agricultural loans	Composite index
1	Saran	0.795	-0.188	-0.162	1.947	0.256	−0.241	0.598
2	Siwan	0.876	-0.660	0.328	1.984	1.682	−0.252	0.659
3	Gopalganj	0.695	-0.710	1.621	0.148	1.261	−0.326	0.448
4	East Champaran	1.207	0.034	0.863	-0.906	−0.013	−0.490	0.115
5	West Champaran	1.063	0.260	3.404	-0.974	−0.014	−0.591	0.524
6	Muzaffarpur	0.348	0.994	-0.117	1.116	0.013	−0.547	0.237
7	Vaishali	−1.170	-0.383	-0.474	2.071	0.596	−0.275	0.064
8	Sitamarhi	−2.009	0.286	-0.786	-0.242	−1.177	−0.320	-0.708
9	Darbhanga	0.135	0.683	-0.162	0.433	−0.502	1.270	0.309
10	Madhubani	−0.311	-0.487	-0.830	-0.838	−1.113	−0.304	-0.647
11	Samastipur	0.409	-0.513	-0.474	0.532	−0.417	−0.392	-0.142
12	Begusarai	0.161	2.652	1.175	-0.068	1.233	4.173	1.554
13	Bhagalpur	0.703	0.753	0.283	-0.906	−0.013	0.499	0.219
14	Saharsa	−0.242	-0.416	-0.384	-0.831	1.014	–	-0.171
15	Purnia	−0.521	-0.040	0.194	-0.701	−1.089	−0.433	-0.431
16	Katihar	0.190	-0.236	-0.206	0.489	−0.615	−0.231	-0.101
17	Madhepura	0.043	2.236	-0.786	-0.875	1.655	−0.276	0.332
18	Khagaria	1.294	-1.143	-0.162	0.514	0.406	0.824	0.288
19	Supaul	−0.141	-0.351	-0.875	-0.999	0.795	–	-0.314
20	Araria	−1.239	-1.223	-0.741	-0.782	−0.986	0.433	-0.907
21	Kishenganj	−2.752	-1.408	-0.830	-0.869	−2.208	–	-0.512
22	Sheohar	0.161	-1.372	-0.875	-0.242	−0.775	–	-0.620

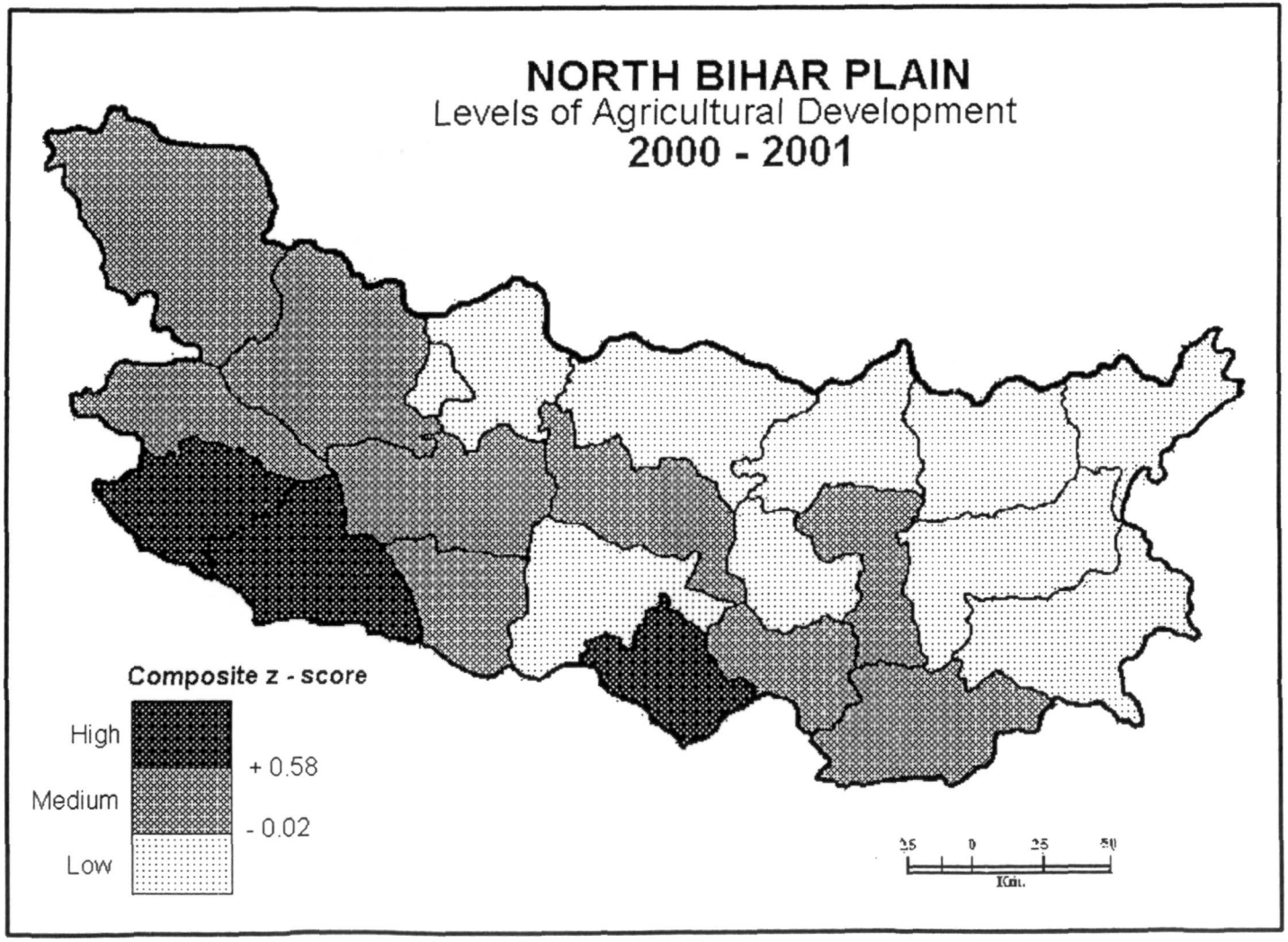

NORTH BIHAR PLAIN
Levels of Agricultural Development
2000 - 2001
Composite z - score
High
Medium
Low
+ 0.58
- 0.02
25 0 25 50
Km.

Fig.3.10

REFERENCES

1. Mohammad, N. (1981): Technological Change and Diffusion of Agricultural Innovation, Perspective in Agricultural Geography, Vol. IV, New Delhi, pp.267.
2. Cantor,I.M. (1967): A World of Irrigation, Edinburg, pp.10-21.
3. King, T. (1953): Water, Miracle of Nature, New York, p.501.
4. Champa, M. (1976): Agricultural Development and the Role of Fertilizers, *Indian Journal of Regional Science*, Vol. 8, No. 1 and 2, pp. 151.
5. Chaudhary, A.K. and Sirohi, A. S. (1974): Allocation of Fertilizers among Crops and Regions in U.P.,*Indian Journal of Agricultural Economics*,Vol.27, No.3,p.47.
6. Kumarswamy,S.(1969):Expanding Role of Co-operative in Agriculture, *Agricultural Situation in India*, Vol.24, No.3.

Chapter IV

AGRICULTURAL DEVELOPMENT

Agricultural development is undoubtedly a multidimensional concept of which crop productivity is one of the vital aspects. The simplest and the crudest measure of crop productivity is the yield per hectare of various crops. A desirable sophistication is introduced by finding out the value of crop produce per hectare of net area sown or per cultivator/agricultural worker. Produce per hectare of net area sown is an expression of the output per unit of agricultural land, and produce per agricultural worker or cultivator reflects the income levels of agricultural population.

Diversification of agriculture is the second vital aspect of agricultural development. Diversification of cropping is an element of agricultural development, which is supported not on economic ground but on considerations of self-reliance in agricultural production and maintenance of soil fertility. Diversified agricultural activities like, dairying, cattle rearing, poultry farming, pig rearing, bee keeping and fishing significantly contribute to the basket of agricultural products and generate additional employment for the surplus agricultural population.

Commercialization of agriculture or the extent of penetration of market forces in an area, and the scale upon which they operate is crucial in tackling every problem of agricultural development. The percentage of cropped area under cash crops may be used as a measure of commercialization of agriculture. Development of agriculture is also to be judged from the degree of equity in farm incomes and nature of agrarian relations (Krishan, 1992).[1]

Sharma (1971)[2] opined that agricultural development should be assessed not only by levels of productivity or trends in agricultural production but also with reference to various physical inputs like irrigation, fertilizers, improved seeds and extent of cultivated area.

It follows that agricultural development is a much more comprehensive concept than normally understood. Agricultural development, in a true sense denotes the quality of the agricultural system of a region in terms of productivity, diversification and commercialization consistent with a desired

state of agrarian relation and ecological balance. The level and the rate of agricultural development may also be distinguished. The former represents a picture prevailing at a particular point of time while the latter stands for the progress achieved over a given period. If the process of agricultural development is regulated on systematic lines, it becomes agricultural development planning.

The term productivity has been used in different meanings and has aroused many conflicting interpretations. Sometimes, it is considered as the overall efficiency with which a production system works, other defined it as a ratio of output to input. Productivity is generally used to express the power of agriculture in a particular region to produce crops, no matter whether that power is natural or due to the efforts of man. It is not a synonym of 'fertility' because fertility denotes the ability of soil to produce all the essential plant nutrients in available form and suitable balance for the plant growth (Shafi, 1984).[3] "Productivity is defined in economics as the output per unit of input, The art of securing an increase in output from the same input or of getting the same output from a smaller input (Pandit, 1965)[4]. He further suggested that increases in productivity, whether in industry or agriculture, are generally the result of a more efficient use of some or all the factors of production, viz. land, labour and capital. Saxon (1964)[5] expressed the productivity as a physical relationship between output and the input which gives rise to the output. In the present study productivity has been taken as a measure of agricultural development.

SPATIAL VARIATIONS IN AGRICULTURAL PRODUCTIVITY IN NORTH BIHAR PLAIN

The productivity indices have been calculated on the basis of Yang's crop formula because it has its relative merit over other methods. It not only gives weightages to the real extent of crops but also is applicable in the agricultural realities of the developing world. Moreover, it is explicitly a relative index of productivity, which measures productivity levels of units of observation with reference to regional yield. The productivity indices have been computed for the period of 2000–2001, taking district as a unit. The crops considered for the

calculation are Cereals (rice, wheat, maize and barley), Pulses (gram, arhar, masoor (lentil), khesari and peas), Cash crops (sugarcane and potato) and Oilseeds (including linseed, rapeseed and mustard). The data has been collected from *Annual and Season Crop Reports, Bihar Through Figures and Official Records of the Directorate of Statistics and Evaluation, Patna, Bihar.* Care has been taken, as far as possible, to ensure the accuracy and reliability of the statistical information obtained.

The areal differences in crop production and productivity were computed by applying 'Crop Yield Index' method devised by W.Y. Yang (1965). This method considers the yields of all crops on a farm compared with the average of crop yields of the region for the period 2000-2001. Before calculating the crop yield index, the average yield of each of the crops grown in the region were determined. Then, by dividing the yield per hectare of the crop on the particular farm by the average yield of the crop in the region, a percentage was obtained which, when multiplied by 100, gives the index number. By using the area devoted to each crop as a weight to multiply this percentage index, the products obtained. By adding the products and dividing the sum of the products by the total crop hectares of the farm and using the crop area as the weight, the resultant average index is the desired index for the particular farm.

PRODUCTIVITY REGIONS (2000–2001)

The productivity indices computed for the districts of North Bihar Plain have been grouped into three distinct categories i.e., high, medium and low. The number of districts in each category has been shown in Table 4.1 and the productivity regions demarcated in Figs. 4.1 to 4.5.

Table 4.1 Number of Districts under Different Productivity Regions with their Indices.

	CEREALS		PULSES		CASH CROPS		OILSEEDS		COMPOSITE INDEX	
Category	Indices	No. of Districts	Indices	No. of Districts	Indices	No. of Districts	Indices	No. of Districts	Indices	No. of Districts
High	Above 105.08	9	Above 100.28	6	Above 95.06	10	Above 98.30	7	Above 97.11	10
Medium	Between 83.3-105.08	7	Between 87.55-100.28	9	Between 95.06-77.75	5	Between 80.43-98.30	5	Between 89.64-97.12	5
Low	Below 83.3	6	Below 87.55	6	Below 77.75	6	Below 80.43	10	Below 89.64	10

I. Productivity Regions of Cereal Crops

Cultivation of cereal crops constitutes the most important position in agriculture of the region. It occupies about 4254 thousand hectares of land accounting for about 91.18 per cent of the total cropped area of the study region. The crop indices are given in Table 4.2. The high productivity region is spread over six western districts namely, East Champaran, West Champaran, Gopalganj, Saran, Siwan, Vaishali and four eastern districts of Saharsa, Madhepura, Bhagalpur and Kishenganj with the productivity indices above 105.08. The high productivity area accounts for 62 percent of the total area under cereals of the region. The high productivity in these districts is due to availability of enough water for irrigation, sufficient use of fertilizers and maximum number of pumpsets and tractors. There are two tracts of medium productivity in the east and south central part of the study region. Both of these regions cover the districts of Purnia, Araria, Supaul, Kathiar, Samastipur, Darbhanga and Khagaria. The productivity indices of this region are between 83.30 and 105.08. It covers an area of 1235 thousand hectares, which accounts for 18.95 percent of the total cropped area. The area under low productivity of cereals is recorded in the districts namely, Muzaffarpur, Madhubani, Sitamarhi, Sheohar and Begusarai with indices of below 83.30 percent. It covers an area of 1197 thousand hectares or 18.37 percent of the total cropped area under cereal crops. The causes of low productivity are lack of irrigation, inadequate dose of fertilizers and less use of technology.

II. Productivity Regions of Pulse crops

Pulses constitute an important ingredient in predominantly vegetarian Indian diet. For the poor people, cereals constitute the staple food, and the major source of energy. However, additions of pulses, which are the main source of vegetable protein in their diet, provide nutritionally balanced food.

Pulses in North Bihar Plain are grown over 166 thousand hectares which accounts for 2.20 per cent of the total cropped area of the region. The productivity indices of pulses are shown in Fig. 4.2 and the indices for various districts are tabulated in Table 4.2. High productivity of pulses has been seen in six districts namely, Kishenganj, Araria, Madhepura, Saharsa,

Table 4.2 Districtwise Productivity Indices in North Bihar Plain-Based on Yang's Method 2000-2001

Sr. No.	Districts	Cereals	Pulses	Cash crops	Oil seeds	Composite index
1	Saran	109.95	85.12	60.00	115.07	92.54
2	Siwan	113.10	98.51	67.77	94.41	93.45
3	Gopalganj	107.00	89.45	84.62	115.07	99.04
4	East Champaran	119.32	71.54	107.22	94.41	98.12
5	West Champaran	108.21	87.79	98.37	73.94	92.08
6	Muzaffarpur	80.10	106.20	101.31	115.07	100.67
7	Vaishali	105.68	74.29	113.46	87.59	95.26
8	Sitamarhi	76.30	74.29	113.46	87.79	87.96
9	Darbhanga	92.68	89.93	95.27	104.77	95.66
10	Madhubani	78.03	88.00	73.70	94.43	83.54
11	Samastipur	97.26	96.38	85.73	115.07	98.61
12	Begusarai	80.25	97.86	106.26	115.07	99.86
13	Bhagalpur	119.32	82.32	84.59	104.77	97.75
14	Saharsa	113.28	101.50	69.84	80.08	91.18
15	Purnia	104.04	81.20	69.12	75.94	82.58
16	Katihar	98.41	91.19	75.05	67.44	83.02
17	Madhepura	116.66	124.47	112.84	75.34	107.33
18	Khagaria	102.32	114.43	113.54	76.64	101.37
19	Supaul	91.56	87.41	119.04	87.59	96.40
20	Araria	102.21	110.64	89.28	64.04	91.54
21	Kishenganj	109.39	106.64	78.11	68.33	90.62
22	Sheohar	76.59	-	-	73.85	75.22

Source: Computed by Author, Data obtained from Bihar Through Figures (2000-2001), Directorate of Statistics and Evaluation, Bihar, Patna.

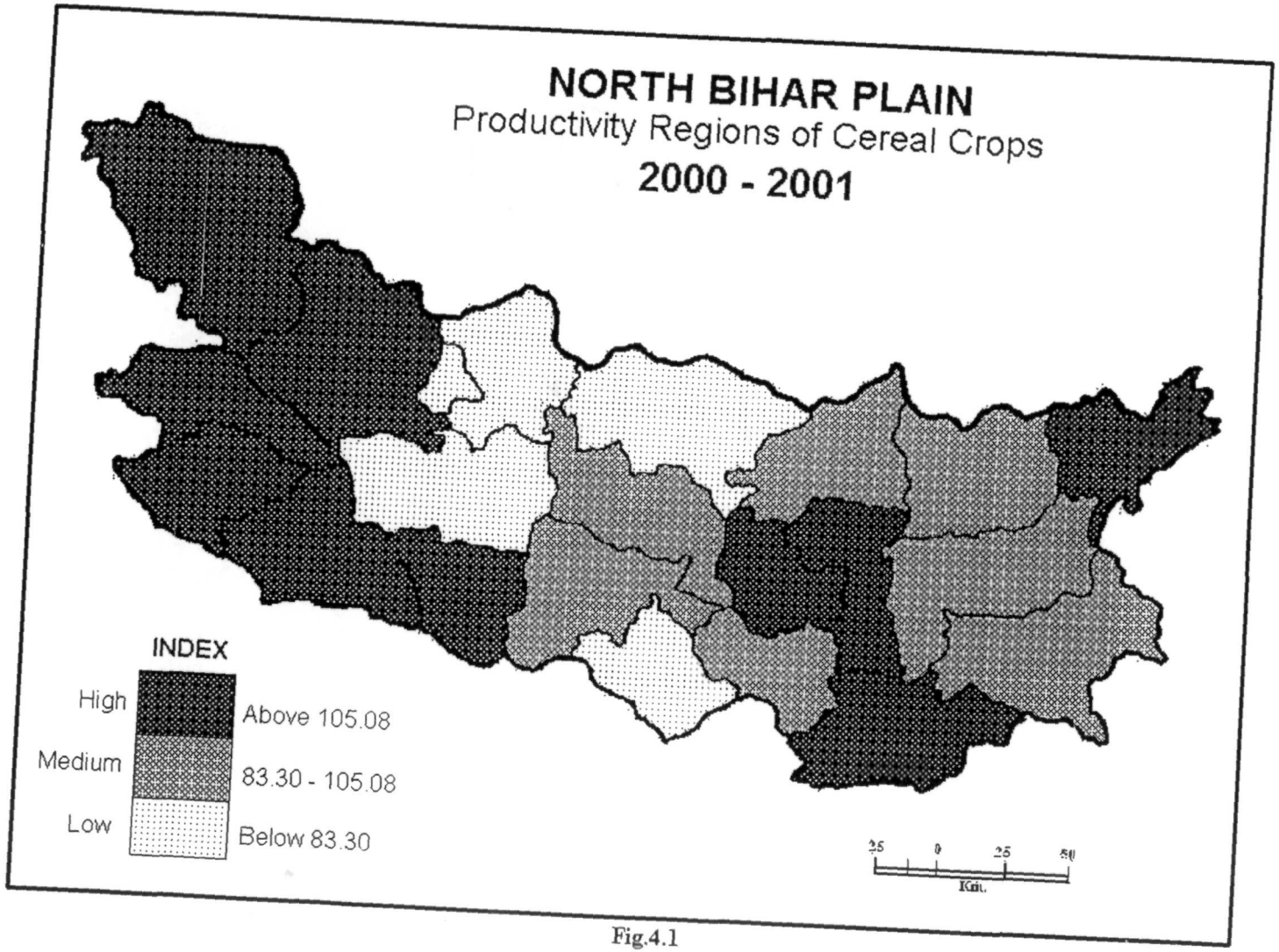

NORTH BIHAR PLAIN
Productivity Regions of Cereal Crops
2000 - 2001
INDEX
High
Above 105.08
Medium
83.30 - 105.08
Low
Below 83.30
25
0
25
50
Km.

Fig.4.1

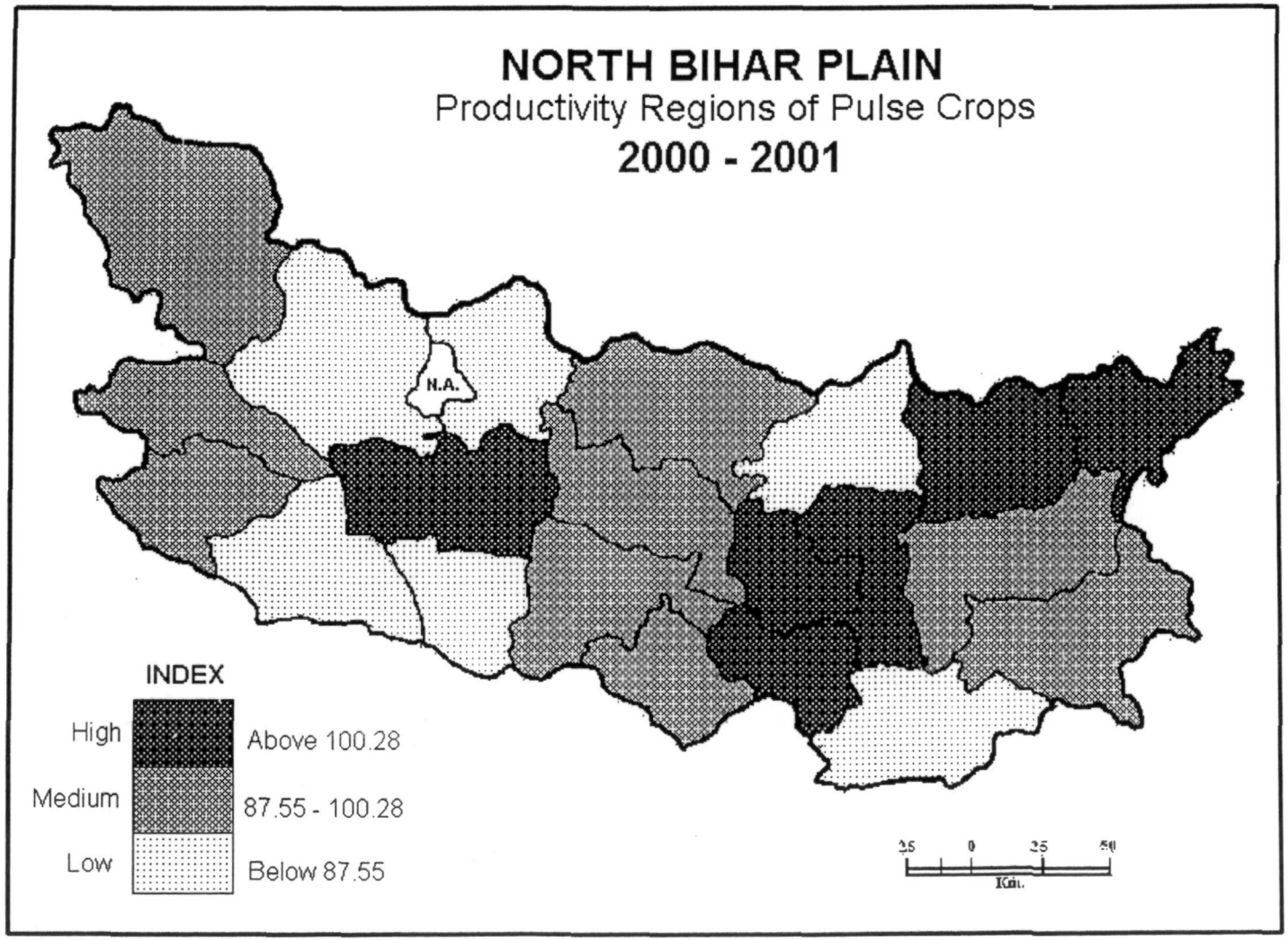

NORTH BIHAR PLAIN
Productivity Regions of Pulse Crops
2000 - 2001
N.A.
INDEX
High
Above 100.28
Medium
87.55 - 100.28
Low
Below 87.55
25 0 25 50
Km.

Fig.4.2

Khagaria and Muzaffarpur, with the crop indices above 100.28. These districts altogether has an area of 38.0 thousand hectares which is 22.89 percent of the total area under pulses in North Bihar Plain. The medium productivity regions of pulses occupies a large area of the study region including the districts of Siwan, Gopalganj, West Champaran, Darbhanga, Madhubani, Samastipur Begusarai, Purnia and Katihar covering 47.59 per cent of the total area under pulses. The productivity indices of these districts range between 87.55 and 100.28. The low productivity districts are Saran, Vaishali, East Champaran, Sitamarhi, Supaul, Purnia and Bhagalpur, which together covers an area of 29.52 per cent of the districts of North Bihar Plain under pulses. The crop indices of this region are below 87.55.

III. Productivity Regions of Cash crops

The cash crop occupies an area of 358 thousand hectares or 5.01 per cent of the total cropped area of North Bihar Plain. It may be seen from Fig. 4.3 that there are two belts of high productivity of cash crops. One of them covers a large area in the western part including the districts of West Champaran, East Champaran, Sitamarhi, Muzaffarpur, Vaishali and Darbhanga. Other areas of high productivity are found forming a continuous belt which extends over the districts of Supaul, Madhepura, Khagaria and Begusarai. All these districts of high productivity together accounted for 38.55 per cent of the total area under cash crops. The high productivity regions having indices above 95.06 are attributed to better irrigation facilities and use of machinery. The districts of Araria, Kishenganj, Samastipur, Gopalganj and Bhagalpur fall under medium productivity and cover an area which account for 34.08 per cent of the total area under cash crops. The productivity indices of these districts range from 77.75 to 95.06. The low productivity districts are Saran, Siwan, Madhubani, Saharsa, Purnia and Katihar, which together cover an area of 27.37 per cent of the districts of North Bihar Plain under cash crops, where the crop indices are found below 77.75. Low productivity is due to lack of better irrigation facilities, dependency on monsoon for irrigation and low doses of chemical fertilizers and lack of credit facilities.

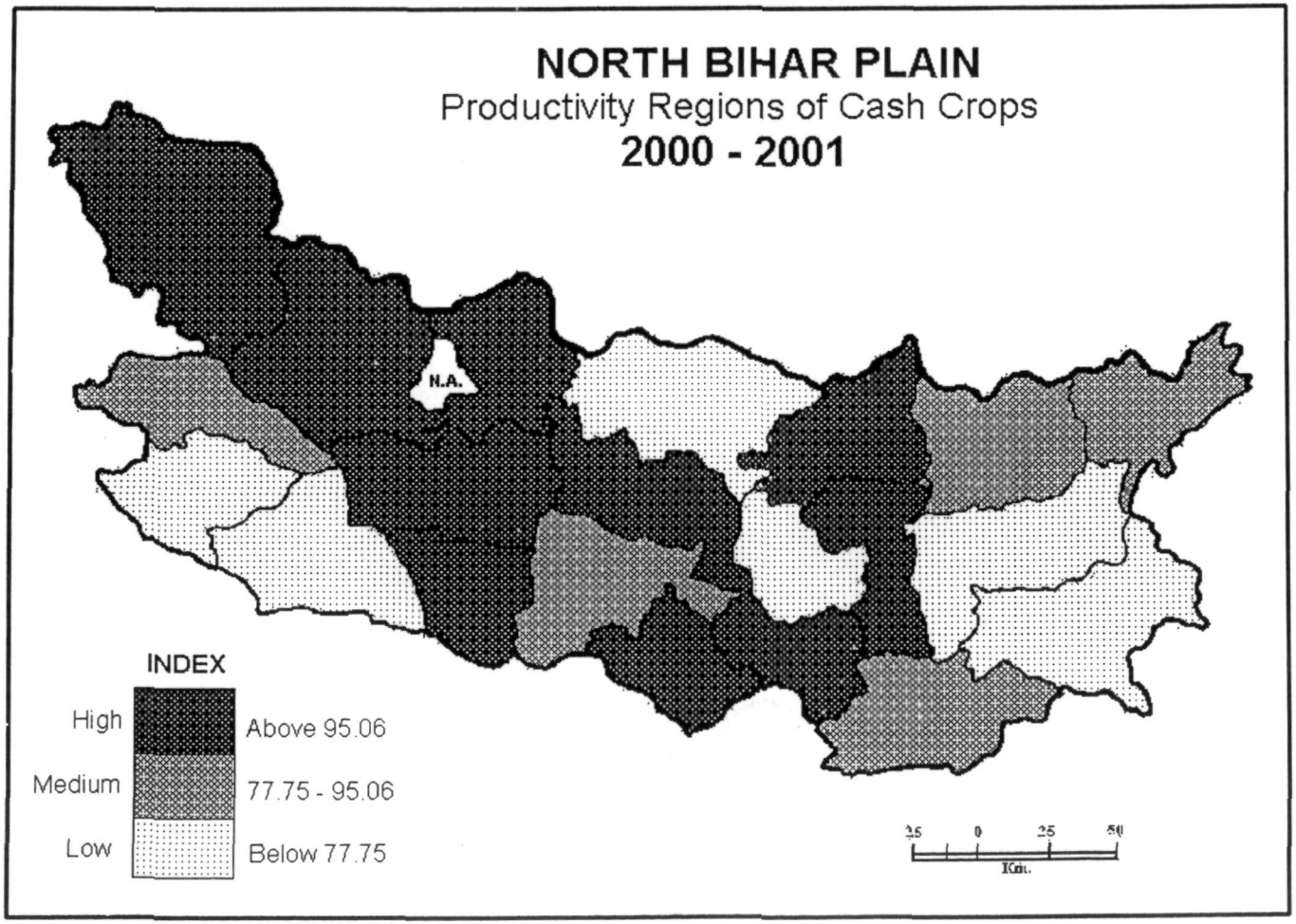

NORTH BIHAR PLAIN
Productivity Regions of Cash Crops
2000 - 2001
N.A.
INDEX
High
Above 95.06
Medium
77.75 - 95.06
Low
Below 77.75
25 0 25 50
Km.

Fig.4.3

IV. Productivity Regions of Oilseed crops

Oilseeds occupy 115 thousand hectares or 1.16 per cent of the total cropped area of North Bihar Plain. The productivity region of oil seeds are shown in Figure 4.4 and the number of districts under high, medium and iow productivity with their indices are tabulated in Table 4.2. There are seven districts namely, Gopalganj, Saran, Muzaffarpur, Darbhanga, Samastipur, Begusarai and Bhagalpur showing high concentration of oilseeds. All these districts of high productivity accounts for 29.57 per cent of the total cropped area under oilseeds and their productivity indices are above 98.30 due to favourable climatic condition for the oilseed cultivation. The medium agricultural productivity is found in the districts of East Champaran, Sitamarhi, Madhubani and Siwan covering 22.60 per cent of the total area under oilseeds. Their productivity indices are between 80.43 and 98.30. Low productivity of oilseeds covers a large area, including seven eastern districts of Kishenganj, Araria, Purnia, Katihar, Madhepura, Saharsa and Khagaria while three western districts namely, West Champaran, Sheohar and Vaishali. These districts together cover an area of 47.83 per cent of the total oilseeds area and the crops indices are below 80.43.

Productivity Regions– based on composite Index 2000–2001

A composite index has been obtained after calculating the agricultural productivity for each group of crop in the districts of North Bihar plain. The positions of each district are given in Table 4.2 and their spatial patterns are shown in Fig. 4.5. The figure shows that there are eight districts namely, Muzaffarpur, Gopalganj, East Champaran, Samastipur, Begusarai, Bhagalpur, Khagaria and Madhepura falling under high productivity region. All these districts together have an area of 1705 thousand hectares which accounts for 34.85 per cent of the total cropped area of the region, with the indices above 97.10. The medium productivity districts are West Champaran, Saran, Siwan, Darbhanga, Vaishali, Saharsa, Supaul, Araria and Kishenganj. It covers an area of 34.62 per cent to the cropped area of the plain. The crop indices range from 89.63 to 97.10. Low category of agricultural productivity occupies

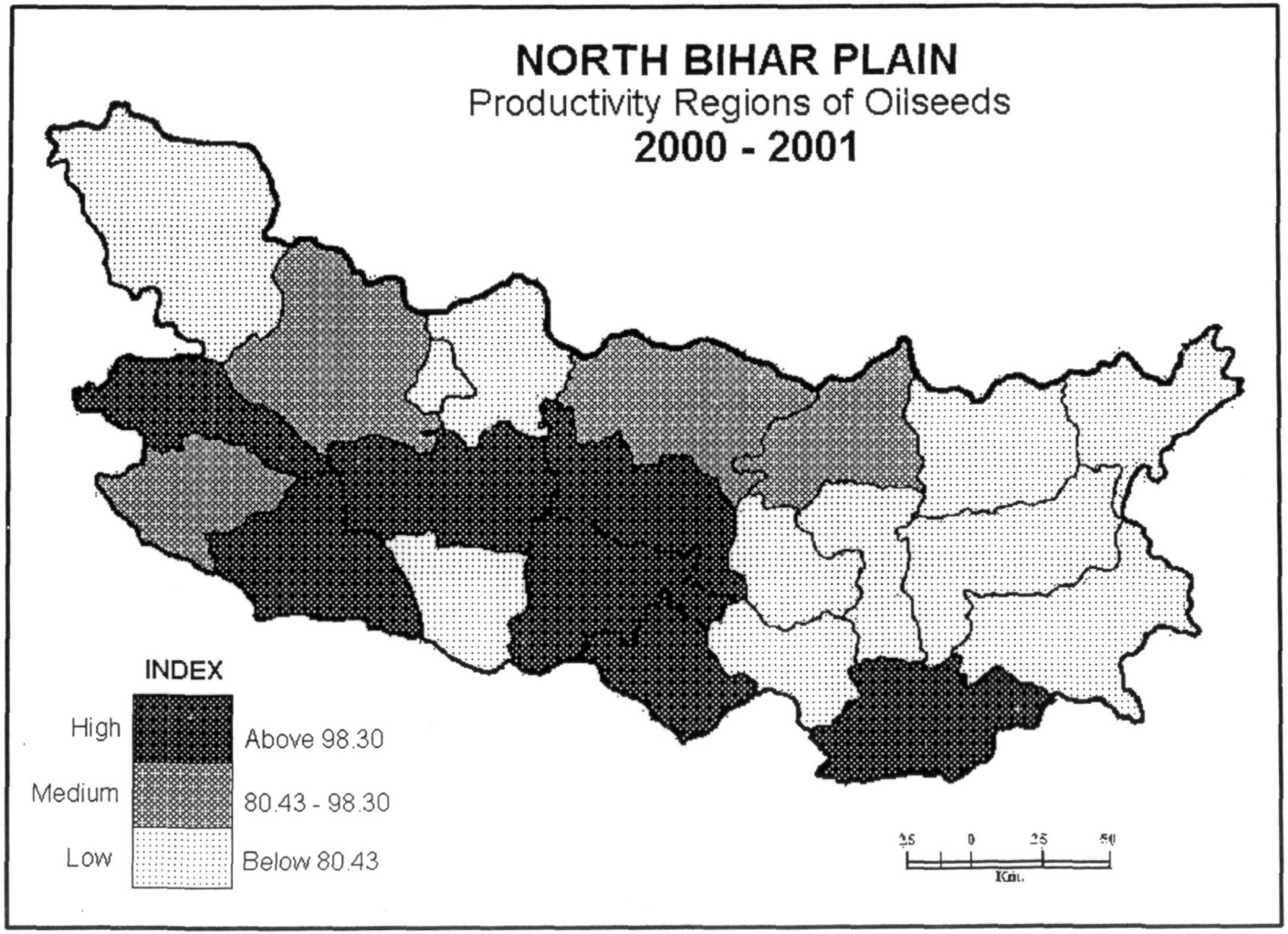

NORTH BIHAR PLAIN
Productivity Regions of Oilseeds
2000 - 2001
INDEX
High
Above 98.30
Medium
80.43 - 98.30
Low
Below 80.43
25 0 25 50
Km.

Fig.4.4

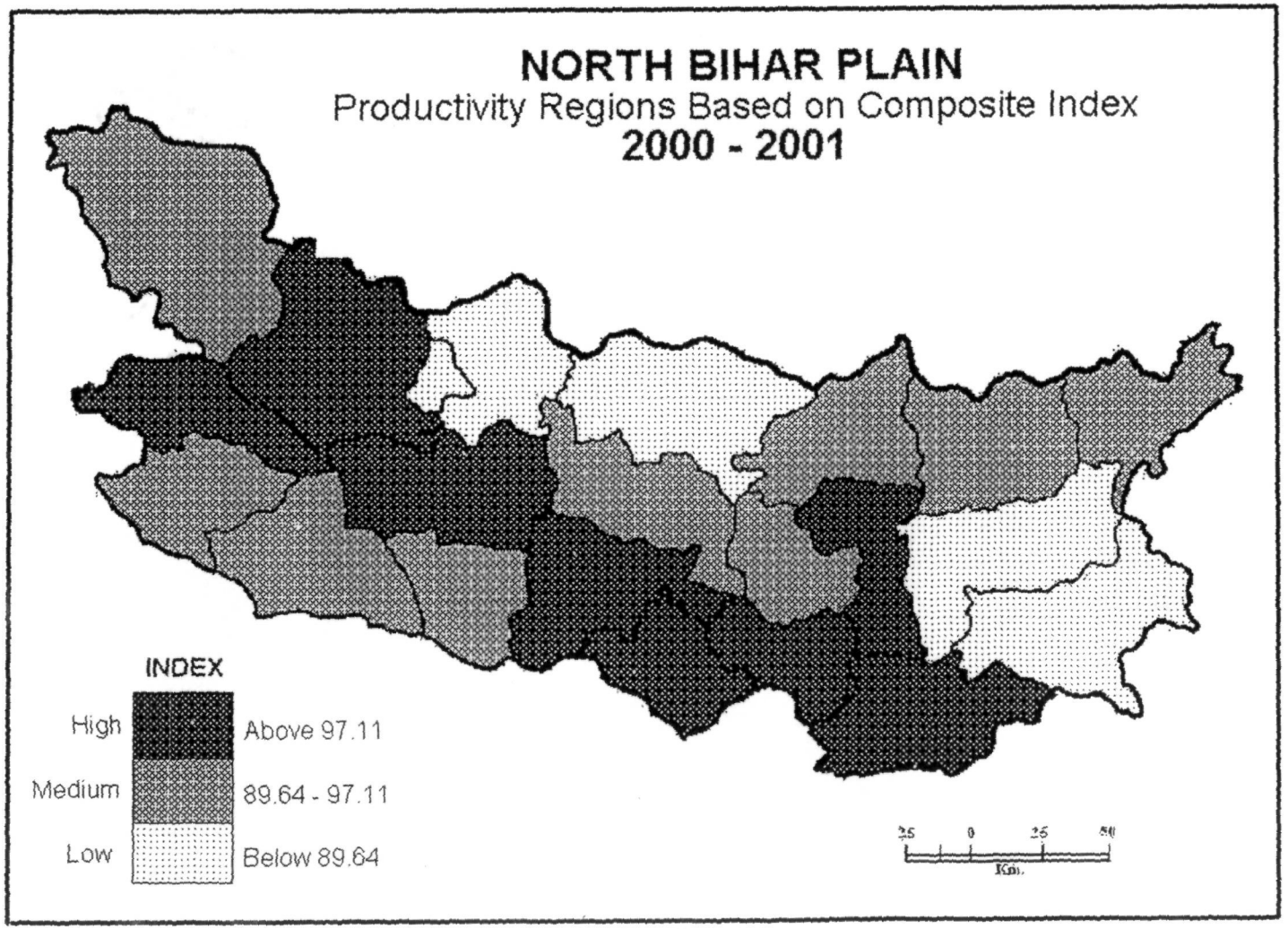

NORTH BIHAR PLAIN
Productivity Regions Based on Composite Index
2000 - 2001
INDEX
High
Above 97.11
Medium
89.64 - 97.11
Low
Below 89.64
25 0 25 50
Km.

Fig.4.5

remaining five districts namely, Purnia, Kathiar, Sheohar, Sitamarhi and Madhubani. They cover an area of 1494 thousand hectares which is 30.53 per cent of the total cropped area of the study region. The productivity indices of low productivity are below 89.63. Having analyzed the composite index of agricultural productivity of the districts of North Bihar Plain during the study period, it has been found that most of the districts recording high productivity lies in the Kosi Command region where percentage of net irrigated area to the total cropped area is maximum and consequently the use of other agricultural input is also high.

LEVELS OF AGRICULTURAL DEVELOPMENT

In order to measure the levels of agricultural development in the districts of North Bihar Plain during 2000–2001, eleven indicators have been selected, which are given in Table 4.3.

Table 4.3 Indicators selected for the Measurement of Agricultural Development in North Bihar Plain

Indicators	Definition
X_1	Productivity based on Yang's crop yield index
X_2	Percentage of canal irrigation to the net irrigated area
X_3	Percentage of tube–well irrigation to the net irrigated area
X_4	Percentage of irrigated area by other sources to the net irrigated area
X_5	Percentage of area under High Yielding Varieties of seeds to the total cropped area.
X_6	Consumption of fertilizers (in kg. per hect.)
X_7	Number of tractors per 10,000 hectares of the total cropped area.
X_8	Number of pumpsets for irrigation per 10,000 hectares of the total cropped area.
X_9	Percentage of net sown area to the total cropped area
X_{10}	Percentage of net irrigated area to the total cropped area
X_{11}	Agricultural loans in Rs. per 1,000 hectare of the total cropped area.

In this part of the study, all the indicators pertaining to input and output which are considered as the indicators of agricultural development have been collectively and spatially analyzed with the help of Composite Z-Score statistical technique, to delineate relatively developed and less developed region of the North Bihar Plain. This method was first used by Smith in 1968 in his study on inequality in Peru followed by D. Smith (1973)[7] and many other scholars. The Z–Score technique is expressed as follows:

$$Zij = (Xij - Xj) / (S\ xj)$$

Where,

Zi_j = Standard score of the i^{th} observation of variables.

Xij = Values of Xj variable on ith observation.

Xj = Mean value of Xj variable.

SXj = Standard deviation on the Xj variable.

After standardizing the indicators, its scores have been added together for each districts, and divided with number of variables considered which give the composite index of that district. The composite standard scores may be algebraically expressed as,

$$\text{Composite Standard Scores (C.S.S.)} = EZij / N$$

Where,

Zij indicators Z–Score of an indicator j in district i.

N refers the number of indicators.

The composite scores of the variables have a wide range of variations among the districts of the region; therefore, these variations may conveniently be grouped into three categories of high, medium and low levels of agricultural development with the help of their composite means Z–Score.

Fig. 4.6 shows the regional pattern of agricultural development in the districts of North Bihar Plain as a whole. The region showing high level of agricultural development covers a large area of the region and includes the districts of Begusarai (+1.009), Khagaria (+0.542) Gopalganj (+0.484), West Champaran (+0.407), Darbhanga (+0.388), Muzaffarpur (+0.340), Siwan (+0.390), Saran (+0.281), Bhagalpur (+0.393) and Madhepura (+0.275). The reasons behind almost all districts falling under high level of agricultural

Table 4.4 Variables Selected for the Assessment of Agricultural Development in North Bihar Plain 2001

Sr. No.	Districts	Productivity based on Yang's crop yield index	Percentage of canal irrigation to the net irrigated area	Percentage of tube-well irrigation to the net irrigated area	Percentage of irrigated area by other sources to the net irrigated area	Percentage of area under HYV of seeds to the total cropped area	Consumption of fertilizers (in kg per ha)	Number of tractors per 10,000 hactare of total cropped area	Number of pumpsets for irrigation per 10,000 ha. of cropped area	Percentage of net sown area to the total crop area	Percentage of net irrigated area to the total cropped area	Agricultural loans in Rs. Per 1000 hectare of total cropped area
1.	Saran	92.54	16.50	68.8	15.30	97.1	131.20	29	629	94.7	52.9	80040.816
2.	Siwan	93.45	19.90	73.8	6.63	97.4	75.33	40	635	94.6	75.7	77869.047
3.	Gopalganj	99.04	41.30	58.7	0.00	96.7	72.07	69	339	96.8	68.9	61723.785
4.	East Champaran	98.12	9.62	85.9	4.48	98.5	121.10	52	169	95.7	48.6	26049.18
5.	West Champaran	92.08	58.20	23.9	7.46	98.0	136.30	109	158	96.9	48.6	4128.06
6.	Muzaffarpur	100.70	1.87	93.9	4.32	95.5	184.30	30	495	90.0	49.1	13781.85
7.	Vaishali	95.26	0.00	84.7	15.30	90.3	93.61	22	649	92.4	58.3	72877.36
8.	Sitamarhi	87.96	1.56	79.7	18.80	87.3	137.70	15	276	95.4	30.1	63049.28
9.	Darbhanga	95.66	0.00	16.9	83.10	94.8	163.80	29	385	95.5	40.8	4083465.6
10.	Madhubani	83.54	6.67	36.0	57.30	93.2	86.71	14	180	85.4	31.1	66391.48
11.	Samastipur	98.61	0.00	100	0.00	95.7	85.01	22	401	97.7	42.3	47319.92
12.	Begusarai	99.86	0.00	90.4	9.59	94.7	2940	59	304	93.5	68.5	1038290.9
13.	Bhagalpur	97.75	7.69	62.8	29.50	96.8	168.50	39	169	94.1	48.6	241008.82
14.	Saharsa	91.18	28.00	65.3	6.67	93.5	91.41	24	181	92.7	65.0	0.00
15.	Purnia	82.58	21.40	66.4	11.20	92.5	116.20	37	202	84.1	31.5	226684.64
16.	Katihar	83.02	11.30	88.8	0.00	95.0	53.24	28	394	75.6	39.0	82240.48
17.	Madhepura	107.30	51.50	37.4	11.10	94.5	134.40	15	174	97.2	75.2	72477.27
18.	Khagaria	101.40	0.00	83.6	16.40	98.8	266.10	29	398	86.5	55.3	311244.24
19.	Supaul	96.40	51.50	46.5	1.98	93.8	43.53	13	154	98.0	61.5	0.00
20.	Araria	91.54	19.10	66.7	14.30	90.0	95.71	16	189	92.0	33.1	226684.64
21.	Kishenganj	90.62	0.00	100	0.00	84.8	38.28	14	175	85.4	13.6	0.00
22.	Sheorhar	75.22	0.00	81.8	18.20	94.9	26.14	13	276	96.2	36.4	0.00
North Bihar Plain		**93.35**	**19.05**	**67.27**	**13.67**	**94.25**	**118.84**	**32.63**	**315.09**	**87.93**	**19.33**	**20771.04**

Source: Data obtained form the Directorate of Statistics and Evaluation, Bihar, Patna and Census Report have been computed by the Author.

Table 4.5 Districtwise Distribution of Variables of Agricultural Development (in Z-scores) in North Bihar Plain 2000-2001

Sr. No.	Districts	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	ΣX/11
1	Saran	-0.118	0.004	−0.010	0.011	0.795	-0.188	-0.162	1.947	0.430	0.256	−0.241	0.281
2	Siwan	0.011	0.166	0.210	−0.459	0.876	-0.660	0.328	1.984	0.413	1.682	−0.252	0.390
3	Gopalganj	0.812	1.441	−0.430	–	0.695	-0.710	1.621	0.148	0.813	1.261	−0.326	0.484
4	East Champaran	0.680	−0.318	0.735	−0.581	1.207	0.034	0.863	-0.906	0.617	−0.013	−0.490	0.166
5	West Champaran	−0.184	3.068	−1.967	−0.417	1.063	0.260	3.404	-0.974	0.829	−0.014	−0.591	0.407
6	Muzaffarpur	1.045	0.817	1.079	−0.590	0.348	0.994	-0.117	1.116	−0.413	0.013	−0.547	0.340
7	Vaishali	0.270	–	0.685	0.011	−1.170	-0.383	-0.474	2.071	0.023	0.596	−0.275	0.123
8	Sitamarhi	-0.775	−0.712	0.469	0.201	−2.009	0.286	-0.786	-0.242	0.555	−1.177	−0.320	-0.410
9	Darbhanga	0.328	–	−2.223	3.732	0.135	0.683	-0.162	0.433	0.578	−0.502	1.270	0.388
10	Madhubani	−1.408	0.542	−1.404	2.319	−0.311	-0.487	-0.830	-0.838	−1.246	−1.113	−0.304	-0.461
11	Samastipur	0.750	–	1.340	–	0.409	-0.513	-0.474	0.532	0.987	−0.417	−0.392	0.202
12	Begusarai	0.929	–	0.929	−0.300	0.161	2.652	1.175	-0.068	0.215	1.233	4.173	1.009
13	Bhagalpur	0.627	0.412	−0.254	0.791	0.703	0.753	0.283	-0.906	0.330	−0.013	0.499	0.293
14	Saharsa	−0.313	0.680	−0.146	−0.461	−0.242	-0.416	-0.384	-0.831	0.081	1.014	–	-0.092
15	Purnia	−1.545	−0.259	−0.102	−0.211	−0.521	-0.040	0.194	-0.701	−1.482	−1.089	−0.433	-0.562
16	Katihar	−0.313	−0.238	0.858	–	0.190	-0.236	-0.206	0.489	−3.027	−0.615	−0.231	-0.371
17	Madhepura	1.971	1.730	−1.345	−0.217	0.043	2.236	-0.786	-0.875	0.898	1.655	−0.276	0.275
18	Khagaria	1.197	–	0.639	0.070	1.294	-1.143	-0.162	0.514	−1.054	0.406	0.824	0.542
19	Supaul	0.434	1.912	−0.867	−0.718	−0.141	-0.351	-0.875	-0.999	1.043	0.795	–	-0.050
20	Araria	−0.262	−0.142	−0.088	−0.043	−1.239	-1.223	-0.741	-0.782	−0.059	−0.986	0.433	-0.387
21	Kishenganj	−0.393	0.430	1.340	–	−2.752	-1.408	-0.830	-0.869	−1.243	−2.208	–	-0.705
22	Sheohar	−2.600	–	0.560	0.170	0.161	-1.372	-0.875	-0.242	0.700	−0.775	–	-0.391

Calculation is based on Table 4.4

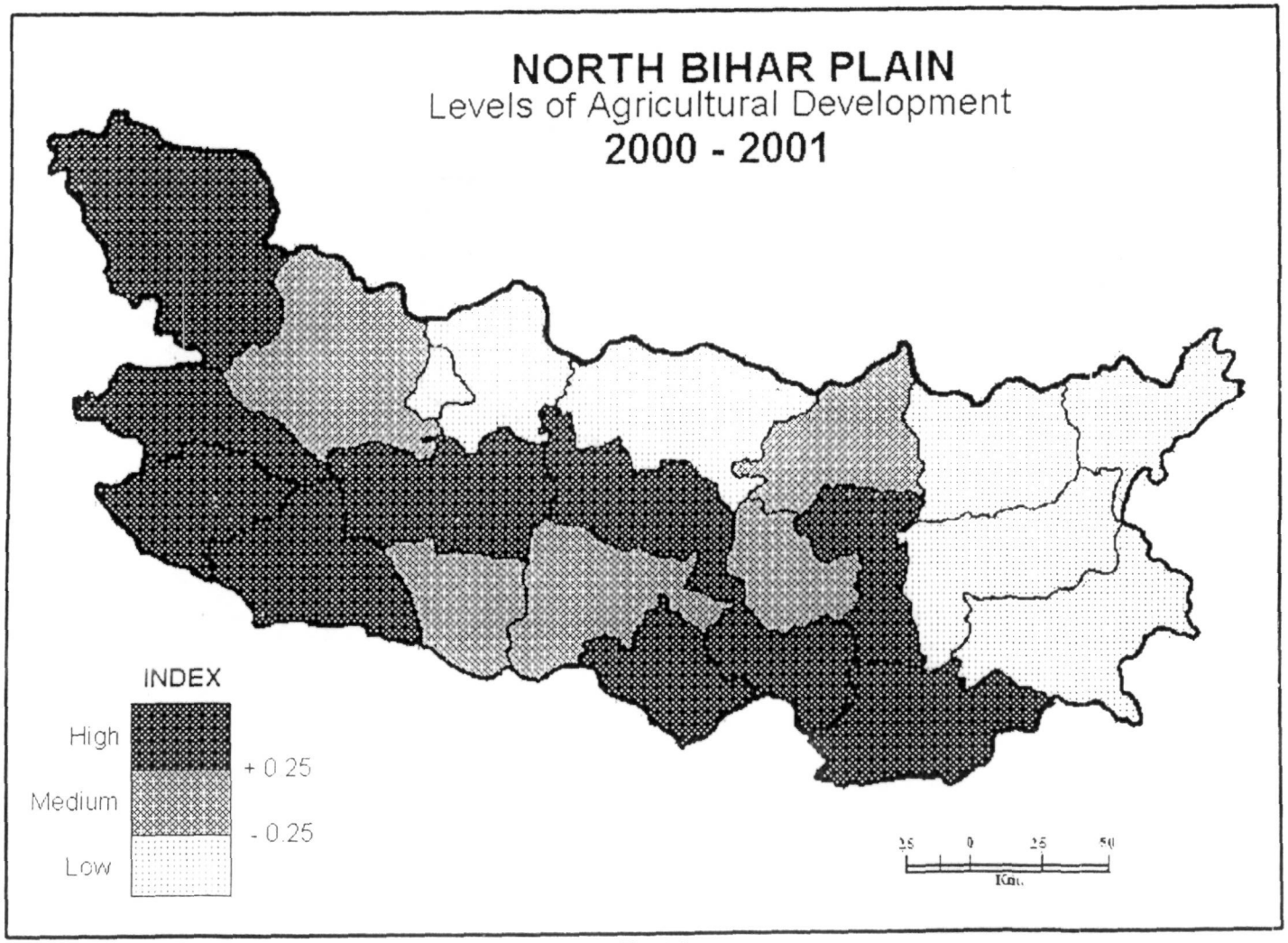

NORTH BIHAR PLAIN
Levels of Agricultural Development
2000 - 2001
INDEX
High
Medium
Low
+ 0.25
- 0.25
25 0 25 50
Km.

Fig.4.6

development are consumption of high doses of fertilizers, maximum concentration of pumpsets for irrigation and tractors for agricultural operations. The farmers of Begusarai, Darbhanga and Khagaria have the advantage of greater agricultural credit facility.

Medium level of agricultural development is found in East Champaran, (+0.116), Samastipur (+0.202), Vaishali (+0.122), Supaul (–0.043) and Saharsa (–0.094). In these districts the development of agricultural technology is in moderate order. Therefore, agricultural development is also moderate. The low level of agricultural development is observed in seven districts namely, Sheohar (–0.391), Sitamarhi (–0.410), Madhubani (–0.461), Araria (–0.387) Purnia (–0.562), Katihar (–0.371) and Kishenganj (–0.705) which form two significant regions. The former three districts lie in the north and remaining districts form a large compact block in the eastern part of the region. The low level of agricultural development in these districts of study area is due to less adoption of modern inputs of agriculture and unfavourable environmental conditions. It is also noted that the region of low level of agricultural development have been areas of poverty and low agricultural income for a long time. A large number of indicators selected to asses the level of development is also low, therefore, the agricultural development is very poor in these districts.

REFERENCES

1. Kishan, G., (1992): *The Concept of Agricultural Development*: in Mohammad,N.(ed.) Dynamics of Agricultural Development, Concept Publishing Company, New Delhi, No. 4, Vol. 7. pp. 29-31.
2. Sharma, P.S. (1971): *Agricultural Regionalization of India* in Chandra Shekhar (ed.) Economic of Socio-Cultural Dimensions of Regionalization, General, New Delhi, pp. 253-78.
3. Shafi, M. (1984): Agricultural Productivity and Regional Imbalances, New Delhi, p.148.
4. Pandit, A.D. (1965): Application of Productivity concept to Indian Agriculture, Productivity, Special issue on Agricultural productivity, 6, (2 & 3), p. 187.
5. Saxon, E.A.(1964): Special Concepts of Productivity, Regional Variation in Agriculture Development and Productivity, *Indian Journal of Agricultural Economics*, Vol. 19, No. 1, p. 266.
6. Yang, W.Y. (1965): Methods of Farm Management Investigation for improving Farm Productivity, No. 80, F.A.O. Rome p.62.
7. Smith, D.M. (1973): The Geography of Social Well Being in the United States, Amol Heiemann, New York, p. 85.

Chapter V

FOOD SECURITY

North Bihar Plain is one of a backward region of the country as well as of the state of Bihar where 80 per cent of reporting area is under cultivation, which provides employment, to about 80 per cent of the total workforce. The region like other under-developed regions of India has negligible effect of the Green Revolution. Hence, it is not able to produce sufficient food for its people. There has been an insignificant increase in per capita availability of food from 127kg/head annually in 1981 to 131 kg in 2001.

The overall food-security concern at the national level entails three basic issues, namely, availability, stability and accessibility (Chaturvedi, 1997[1] and Ghosh, 2000).[2] Availability of enough food for all can be attained through increasing agricultural production within the country as well as regions and also fostering international trade with other nations to import food, if necessary. Caloric availability and foodgrains availability have been selected as the indicators of food availability.

Food stability calls for undertaking appropriate pre-emptive steps, through which harmful, suspended and inter-annual instability of supplies of food can be reduced. Built-in stability needs to be installed in the production, prices, marketing and distribution system. Natural and man- made disasters can often be anticipated and even prevented (Ghosh, 2000)[3]. Basically the food stability comprises the stability in production, prices, marketing and distribution system, which have been assessed with the help of three indicators of varying nature. These are agricultural productivity, storage facilities and public distribution system. Food accessibility refers to adequate and safe food for all which may be made possible by carefully taking into consideration the important factors followed by sound governmental interventions and policies. The vast majority of malnourished and undernourished people do not have, at the first instance, adequate access to natural resources, jobs income or social security. Therefore, food accessibility includes the purchasing power, employment, educational level and access of food at household level, especially to the weaker sections of the society. It

can be measured with the help of indicators such as families above poverty line, main workers to the total population, literacy rate and urbanization.

The present chapter is divided into four sections. The first section deals with the food availability under the two sub-sections of districtwise distribution of the indicators of food availability in terms of caloric intake/head/day and foodgrains availability in kg/head/annum. The second section shows districtwise food stability in terms of the indicators such as foodgrains productivity, Storage capacity and Public Distribution System (PDS). The third section highlights regional patterns of food accessibility in terms of various indicators of food accessibility namely, percentage of working population to the total population, percentage of family above poverty line, literacy rate and urbanization. And the last section briefly analyses the food security regions in North Bihar Plain.

DISTRIBUTION OF FOOD AVAILABILITY

Availability of food can be attained through efficient domestic production, import of food from other countries or regions as well as food aid. Caloric availability and foodgrains availability have been selected as the indicators of food availability for the present study. All these indicators have been attempted separately and their aggregate position has also been examined.

Regional Patterns of Caloric Availability

One of the important functions of food is to provide energy to human body measured in terms of calories. The calorie is a measure of the general health of a person because it determines the amount of heat and energy needed to run the human machine. "Without an assured nutritional adequacy, food security looses its meaning" (United Nations 2000 quoted in Vyas, 2000)[4]. The caloric intake not only depends upon foodgrains but also upon other sources of food like fruits, dairy products, sugar, meat etc. In the food system of India, 75 per cent of the calories are derived from cereals, starchy roots (potato), pulses and sugar. On an average Indians consume 51 gms. of total protein daily with only 6 gms. derived from animal sources. The consumption of fruits and vegetables is less than one- fourth of that in the rich

Table 5.1 Districtwise Growth in Foodgrains Availability and Coloric Availability in North Bihar Plain (1981-2001)

S. No.	Districts	1980-81		1985-86		1990-91		1995-96		2000-01	
		A	B	A	B	A	B	A	B	A	B
1.	Saran	108	1198	139	2183	154	1700	161	1608	127	1650
2.	Siwan	135	1486	179	2542	170	2024	186	2143	172	2108
3.	Gopalganj	130	1454	190	2792	227	2163	211	3268	188	2566
4.	East Champaran	162	1725	180	2077	173	2122	181	2480	180	2533
5.	West Champaran	217	2299	221	3177	169	3317	213	3162	203	3200
6.	Muzaffarpur	100	1105	122	18.79	104	1196	135	2052	119	1882
7.	Vaishali	75	845	101	1889	75	839	85	1429	102	1500
8.	Sitamarhi	76	790	84	1131	96	971	123	2377	95	1439
9.	Darbhanga	158	1669	126	2503	98	1111	119	1438	71	2199
10.	Madhubani	67	493	77	2197	130	1563	127	2986	95	1394
11.	Samastipur	143	1710	151	2352	169	979	128	1486	107	1993
12.	Begusarai	124	1297	149	1840	173	1856	174	2233	116	1986
13.	Bhagalpur	158	1569	129	1567	256	2936	207	2240	107	1462
14.	Saharsa	154	1653	141	1904	136	1519	143	2326	240	2094
15.	Purnia	126	1342	203	1577	138	1495	131	1932	132	2326
16.	Katihar	-	-	161	1971	181	2074	166	1983	141	2002
17.	Madhepura	-	-	177	1722	151	1672	144	2204	203	2639
18.	Khagaria	-	-	-	-	-	-	180	2382	222	2583
19.	Supaul	-	-	-	-	135	1476	171	2070	152	2379
20.	Araria	-	-	-	-	127	1441	134	2485	152	2249
21.	Kishenganj	125	1255	126	1669	114	1398	138	1685	221	2549
22.	Sheohar	-	-	-	-	-	-	-	-	105	1468
North Bihar Plain		**127**	**993**	**148**	**2249**	**138**	**2000**	**173**	**2553**	**131**	**1944**

A: Foodgrains availability (in kg per head per annum)

B: Caloric availability (per head per day)

Source: Data obtained form the Directorate of Statistics and Evaluation, Bihar, Patna and Census Report have been computed by the Author.

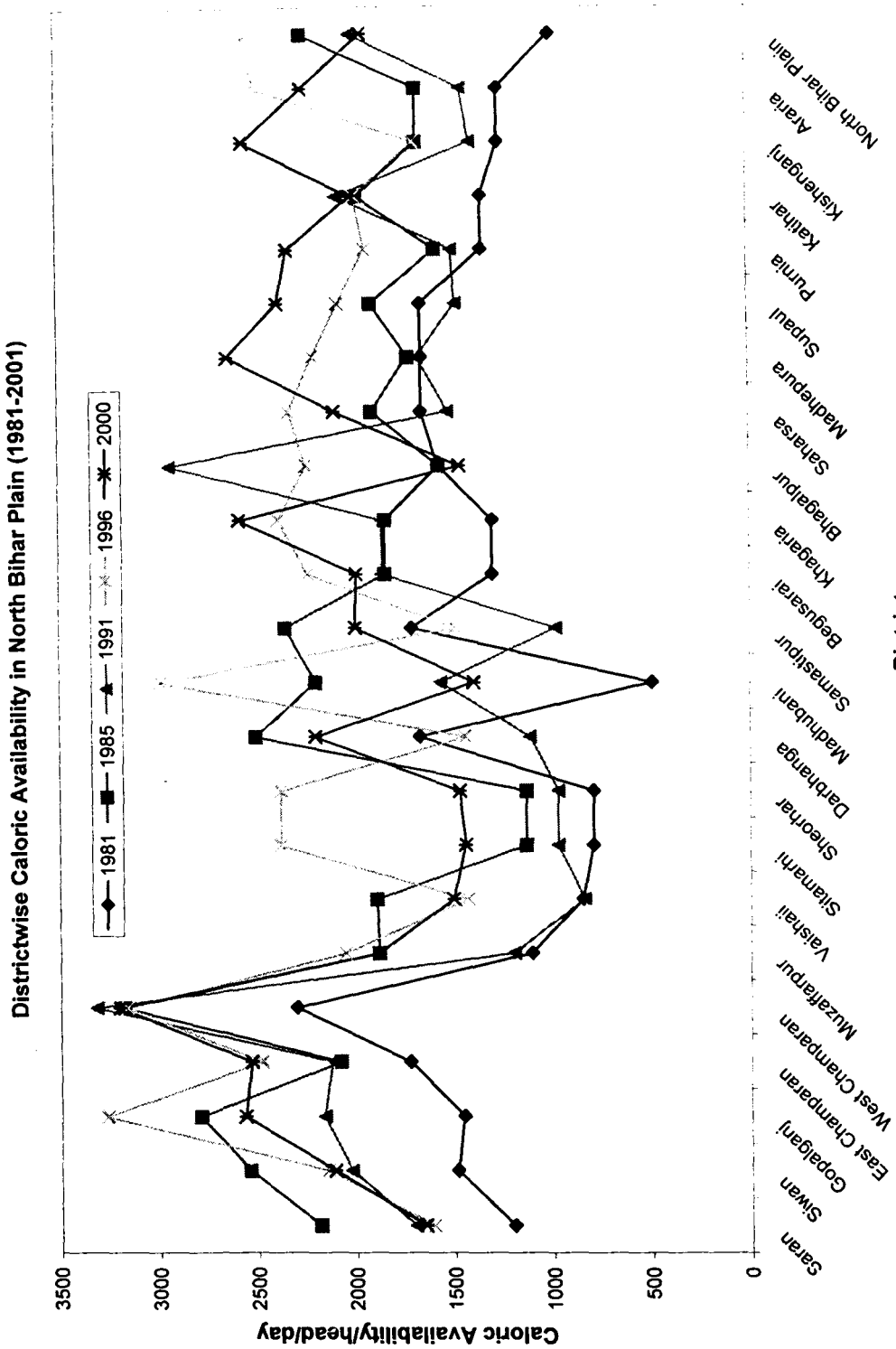

Districtwise Caloric Availability in North Bihar Plain (1981-2001)
1981
1985
1991
1996
2000
Caloric Availability/head/day
3500
3000
2500
2000
1500
1000
500
0
Saran
Siwan
Gopalganj
East Champaran
West Champaran
Muzaffarpur
Vaishali
Sitamarhi
Sheohar
Darbhanga
Madhubani
Samastipur
Begusarai
Khagaria
Bhagalpur
Saharsa
Madhepura
Supaul
Purnia
Katihar
Kishenganj
Araria
North Bihar Plain
Districts

Fig. 5.1

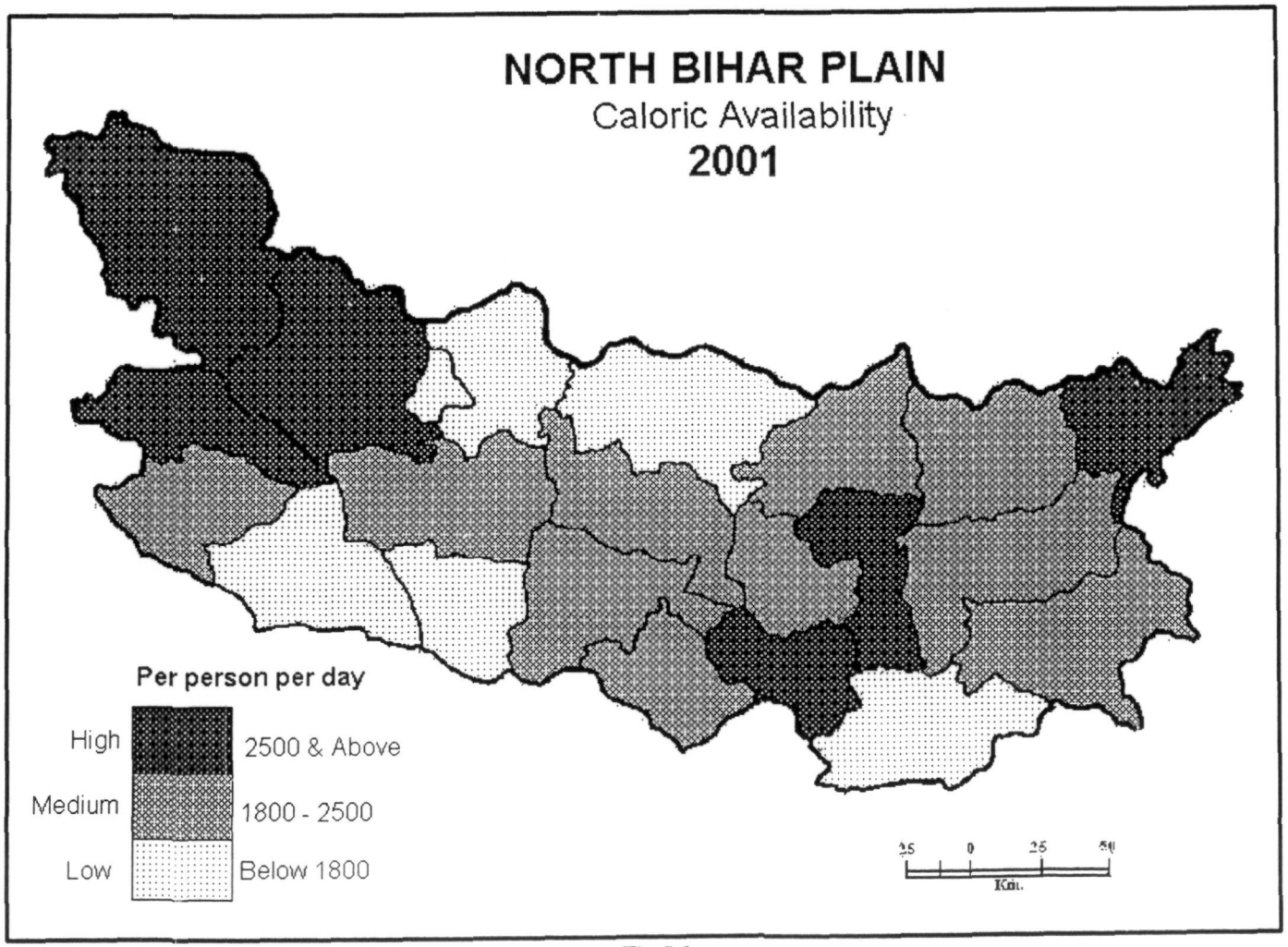

NORTH BIHAR PLAIN
Caloric Availability
2001
Per person per day
High
2500 & Above
Medium
1800 - 2500
Low
Below 1800
25 0 25 50
Km.

Fig.5.2

countries. In India, the vegetable protein is largely derived from pulses and nuts and most of the animal protein is derived from milk. The caloric intake also depends upon the food habits of people. It is also important to note that caloric intake of people not only depends upon the production or availability but also on accessibility or the purchasing power of the people.

The nutrient's needs can be assessed in terms of caloric requirements which, vary with an individual's physique, occupational structure, level of physical activity, age and sex composition and climate (Mitra and Mukherji, 1980)[5]. Caloric value is measured in terms of kilocalories and grams calories required and attained for population which shows the adequacy of diet, in terms of quantity of food (Gopalan, et al., 1966)[6]. The standard caloric intake for an adequate diet varies from average of 2300 calories per person per day in the Far-East to about 2700 calories in Canada and CIS countries (earstwhile USSR). In the US, the calories requirement range between 3000 to 3300 calories per person per day. Most of the Indian scholars, on the basis of 'Diet Atlas of India' published by the Indian Council of Medical Research have worked out that on an average the standard caloric requirement is 2400 calories per person per day. (Kravadal, 2001)[7] mentions that average daily caloric requirement in the world per person are 2800 calories. More than 70 per cent of caloric intake in India is derived from foodgrains. Considering the distribution of persons in different age and sex groups and in different activities in India, the average per capita requirement of calories would be about 2400. As against, the all India average calories consumption is of about 2000 per person per day, the caloric intake in the study area is found below national average in 2001. The World Food Programme has classified the undivided state (i.e., before bifurcation into the new states of Bihar and Jharkhand took place on November 2000) of Bihar as the only state in India suffering from extreme food insecurity and which is not self sufficient in foodgrains production. In the year 2001, the annual production of foodgrains is recorded 7.08 million tones in the North Bihar Plain, which accounts for 131 kg. per person per year. As the districtwise data of import of foodstuff is not available therefore the caloric availability is calculated only for domestic production of foodgrains, oilseeds, sugar and potato from 1981 to 2001.

Table 5.1 indicates that the North Bihar Plain has recorded a fluctuating trend of food availability over a period of two decades from 1981 to 2001 as it has remained 992 calories per head per day in 1981, 2249 calories in 1985, 2000 calories in 1990-91, 2553 in 1995 and 1944 calories in 2000-01. It is clear from the table that the region has not been able to fulfill the total requirement of caloric intake of its people even at national standard level i.e., 2400 calories per head/day, except the year of 1995-96 when production was sufficient.

The distributional pattern of caloric availability during 2001 among the districts of North Bihar Plain is not similar as it varies from 1394 calories per head/day in Madhubani to 3200 calories per head/day in West Champaran. The districts of comparatively higher caloric availability than the caloric requirement in India are West Champaran (3200), Gopalganj (2549), East Champaran (2533), Khagaria (2583), Kishenganj (2549) and Madhepura (2639), which lie in the range of 2500 and above calories per head per day. The districts of West Champaran, East Champaran and Gopalganj form a compact block in western part of the region. This area of high food availability is attributed to certain advantages like availability of assured irrigation water from Gandak command canals and presence of fertile calcareous alluvial soil which helps in giving high yield to the crops. Basic cause of high caloric availability in these districts is rice cultivation and sugarcane cultivation owing to high level of caloric value. Kishenganj (2549), Madhepura (2639) and Khagaria (2583) also are found in the region of high caloric availability of food. These districts lie in the eastern part of the study area. The main cause of high availability of food, in these areas, is low concentration of population. Ten districts fall under the category of high (1800 to 2500) caloric availability per head, which include Purnia (2326), Supaul (2383), Araria (2249), Katihar (2002), Siwan (2108), Saharsa (2094), Darbhanga (2199), Samastipur (1993), Begusarai (1986) and Muzaffarpur (1982). The former six districts lie in the east while the latter four districts form a notable region in central part of the study area. These districts also record moderate facilities of irrigation. There are six districts namely, Saran (1650), Vaishali (1500), Sitamarhi (1439), Sheohar (1468), Madhubani (1394) and Bhagalpur (1462) recording even less than 1800 caloric

availability per head per day and spread over eastern and northern part of the region. The main reason behind the low caloric availability in these districts is the tremendous growth of population during the period. Besides this, lack of irrigation facilities, low consumption of fertilizers and adverse climate are also cause of low availability of food. In the districts of Vaishali, Samastipur, Begusarai and Bhagalpur, excessive rain and wet conditions restrict the cultivation of wheat and pulses. These districts owing to be locating proximity in the river banks annual flooding destroy the standing crops.

It is thus clear from the foregoing discussion that in the case of caloric intake, if the standard requirement is considered (2400 kcal.), the present supply is highly deficient in a large number of the districts. This shortage is mainly due to the inadequate supply of foodgrains. This would suggest that there is need for a balanced food production in order to provide a better and balanced nutritional intake for the people of these districts.

Regional Patterns of Foodgrains Availability

Cereals and pulses are collectively designated as foodgrains (Adige, 1974)[8]. For present analysis of foodgrains availability only domestic production of foodgrains per head per annum has been taken into account. Table 5.1 reveals that the North Bihar Plain shows a fluctuating trend of foodgrains production as it was 127 kg. per head in 1981, 148 kg. per head in 1985, 138 kg. per head in 1991, 173 per head in 1995 and 131 kg. per head in 2001. During 1995 the region as a whole has achieved much better production in foodgrains than other periods which has been taken into consideration for analysis (1981-2001). The reason for decline in the availability of foodgrains production during all periods excepts 1995 appears to be the impact of flood because North Bihar Plain remains in the grip of flood almost each and every year.

During the year 2001, it is estimated that 8.43 million tones of foodgrains have been required to meet the minimum requirements of the existing population but actual production, however, 7.08 million tones. Thus, there is a shortage of food up to the tune of 1.35 million tones. The regional average in respect of the availability of foodgrains has worked out to 131 kg. per head per annum and the national average being 173 kg. as against a

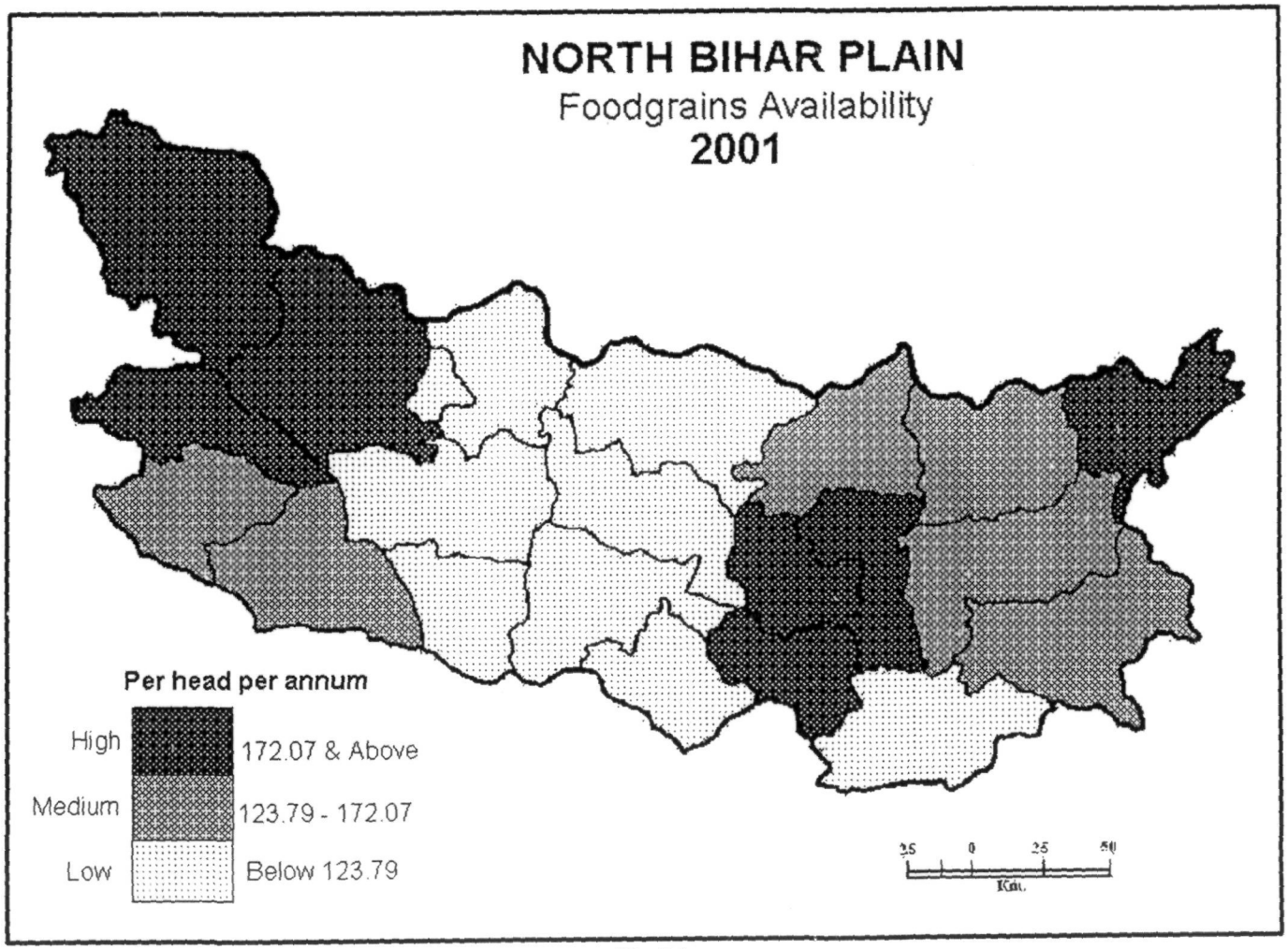

NORTH BIHAR PLAIN
Foodgrains Availability
2001
Per head per annum
High
172.07 & Above
Medium
123.79 - 172.07
Low
Below 123.79
25 0 25 50
Km.

Fig.5.3

minimum requirement of 176 kg . This, clearly, implies an overall deficit in the supply of foodgrains to the extent of 45.0 kg. per capita per annum in the case of North Bihar Plain. There is marked disparities in the availability of foodgrains in different districts for which data was computed. During the year 2001, the interdistricts foodgrains availability is found varying between 95 kg. per head in Madhubani to 240 kg. per head in Saharasa. Table 5.1 shows that, there are 9 out of 22 districts where the per capita availability of foodgrains per day was more than 172.02 kg. These districts are Saharasa (240), Khagaria (222), Kishenganj (221), West Champaran (203), Madhepura (203), Gopalganj (188) and East Champaran (179). The basic causes of high availability of food in these districts are high agricultural productivity and higher concentration of food crops. Paddy is the leading crops in these districts. In the remaining fifteen districts the figures are less than the required values and ranged from severe to small and marginal shortages. Districts of Siwan (172), Supaul (152), Araria (152), Katihar (141), Purnia (132) and Saran (127) fall under the medium category of foodgrains availability (123.79 kg. to 172.07 kg. per head per annum). In these districts owing to moderate facilities of irrigation and unfavourable environmental condition, food availability is remaining moderate. The remaining districts namely, Sitamarhi (119), Begusarai (116), Samastipur (107), Bhagalpur (107), Sheohar (105), Darbhanga (102) and Madhubani (95) record very low per head production of foodgrains. The range of these districts is below 123.79 kg. These districts experience low availability of food per head per annum due to backwardness of agriculture, owing to low doses of modern agricultural inputs such as HYV of seeds, chemical fertilizers and assured means of irrigation as well as concentration of human population.

RIGIONAL PATTERNS OF OVERALL FOOD AVAILABILITY

In order to examine overall the food availability in the region for 2001, the standard score additive model has been taken into consideration and Z-score of two indictors such as caloric availability per head per day and foodgrains production per head per annum have been obtained. With the help of calculated Z-scores, composite Z-scores for overall food availability have

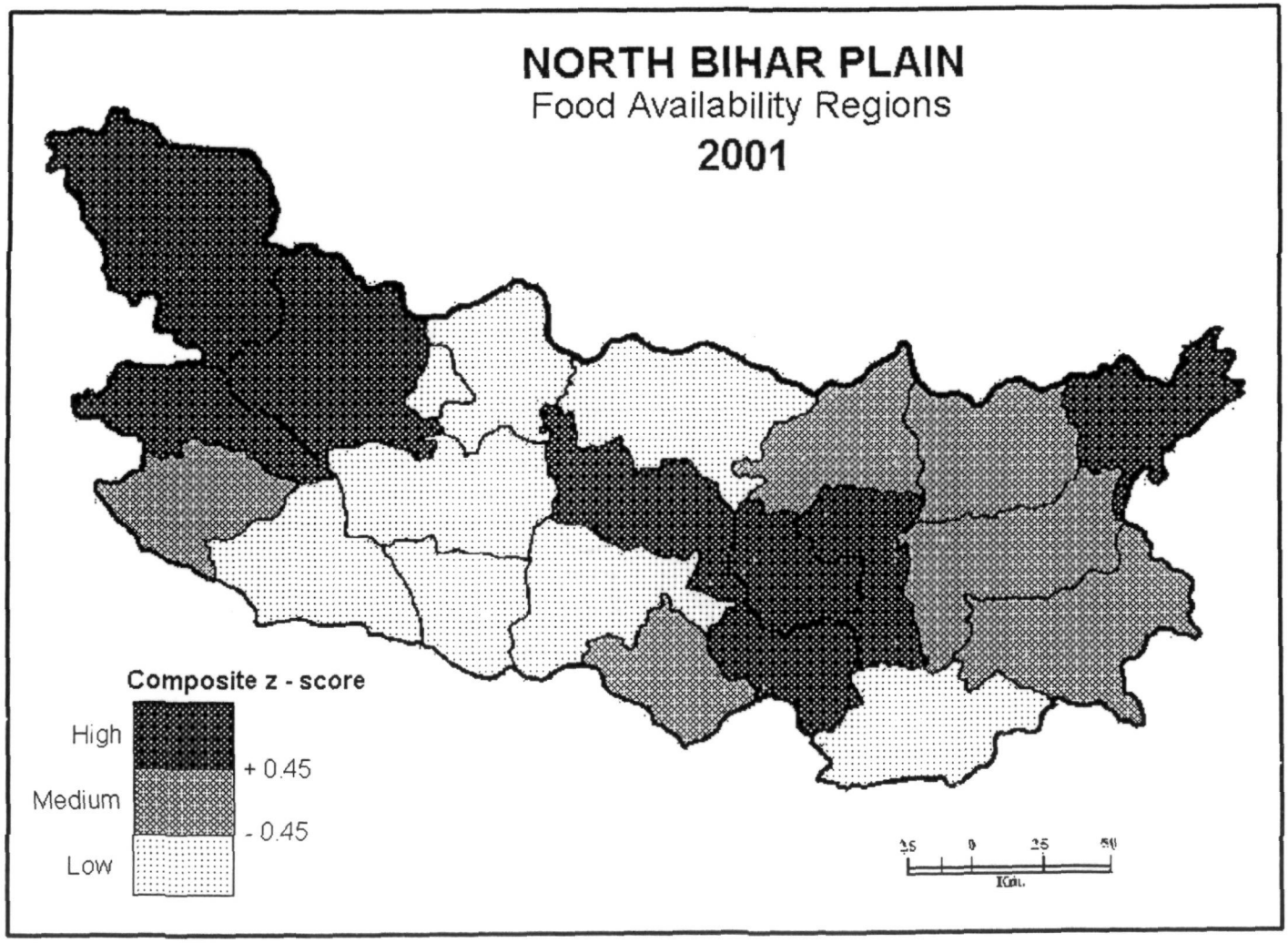

NORTH BIHAR PLAIN
Food Availability Regions
2001
Composite z - score
High
Medium
Low
+ 0.45
- 0.45
25 0 25 50
Kms.

Fig.5.4

been worked out at districts level and food availability regions have been delineated (Table 5.10).

The spatial distribution of food availability in the study area is divided into three categories of high (+0.45 and above) medium (+0.45 to –0.45) and low (below -45) as shown in Fig. 5.4. It highlights that the high food availability region is comprised of eight districts namely, West Champaran (1.71), Khagaria (1.26), Kishenganj (1.22), Madhepura (1.12), Saharsa (0.94), Gopalganj (0.90), East Champaran (0.77) and Darbhanga (0.69). Fertile soils and adequate irrigation facility provide ideal condition for high intensity of crops. The role of skill-educated farmers is also responsible for high productivity in this region. District of Saharsa which lies in the western margin of North Bihar Plain has the advantages of irrigation facilities from Kosi command canals and fertile alluvial soil for a good yield and low population concentration. Six districts namely, Siwan, (0.255), Araria (0.198), Supaul (0.33) Begusarai (-0.440), Purnia (0.070) and Katihar (-0.168) fall under the category of medium availability (+0.45 to –0.45 composite Z-score). Remaining districts of Saran (-0.675), Muzaffarpur (-0.518), Vaishali (-1.088), Sitamarhi (-1.224), Samastipur (-0.525), Begusarai (-1.269), Bhagalpur (-1.075) and Sheohar (-1.090) come under the category of low food availability and covered most part of the region.

It may be concluded from the above analysis that the majority of the districts are found in the categories of either low or medium overall food availability in the region which suggest that there is need of a balanced regional agriculture development in order to provide a better and balanced nutritional intake for the people of the study area. There is urgent need for increasing the yield of cereals, oilseeds and pulses, by adopting new technology, increasing facilities for irrigation, by applying more fertilizers and manures, using HYV of seeds and by safeguarding the region against devastating floods. This will not only enable the rural inhabitants to cater to their local requirements adequately, but will also be in position to produce surplus food for other parts of the state. A balanced nutrition also warrants the development of animal husbandry. However, dairy products have not been taken into consideration in the present study on account of the limitation of data and vast domain of the analysis.

DISTRIBUTION OF FOOD STABILITY

Generally, the food stability includes the components of stability in production, price, marketing and distribution system. It can be measured with the help of indicators such as foodgrains productivity, storage capacity and Public Distribution System (PDS).

Foodgrains Productivity

Yield level in kg/hectare has been selected as a measure of productivity and stability in production. The yield of foodgrains has been discussed in detail in the previous chapter.

Table 5.8 indicates that the yield of foodgrains (kg/ hectare) is highest in the districts of West Champaran, East Champaran, Gopalganj Madhubani, Khagaria, Madhepura, Samastipur and Siwan where it is above 2078.86 kg. per hectare, while it is lower in the districts of Sitamarhi, Darbhanga, Purnia, Katihar, Araria, Kishenganj, Begusarai, Bhagalpur and Supaul where it is even less than 1660.14 kg. per hectare. The remaining districts namely, Saran, Muzaffarpur, Vaishali and Saharsa fall under medium category where yield is between 1660.14 to 2078.86 kg. per hectare.

Storage Capacity

Storage capacity of foodgrains is also one of the important indicators of stability, because the food stocks and distribution system depend upon the storage facilities and also minimizes the food losses. Hence food storage capacity per thousand of population is being taken as a measure of food storage capacity. Storage of foodgrains becomes necessary soon after the primary processing is over. The purpose of storage is to keep foodgrains in good condition and to minimize the post harvest losses till they require further processing, marketing and ultimately for consumption. The regions which do not posses adequate food storage facilities, a lot of foodgrains thus, procured has to remain on the railway platforms, road sides and in the open space and a good deal of it gets destroyed in rains. In order to prevent the losses and to have foodgrains within a manageable space, a number of storage is used. Storage of foodgrains becomes necessary soon after the primary processing is

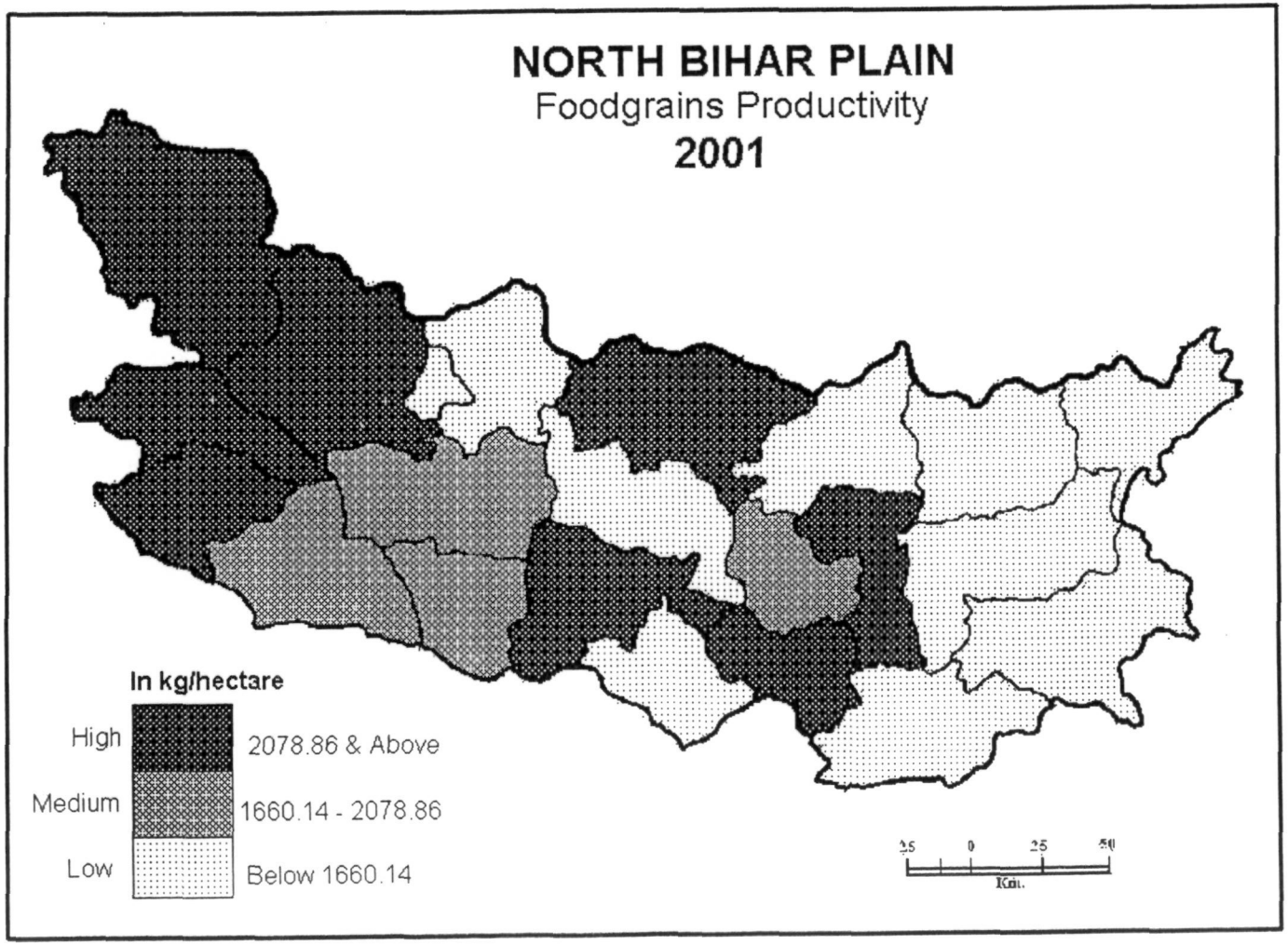

NORTH BIHAR PLAIN
Foodgrains Productivity
2001
In kg/hectare
High
2078.86 & Above
Medium
1660.14 - 2078.86
Low
Below 1660.14
25 0 25 50
Km.

Fig.5.5

Table 5.2 Districtwise total Storage Capacity in North Bihar Plain 2001

S.No.	Districts	State Govt. Capacity in MT	Storage Capacity with FCI in MT	Total Capacity in MT
1.	Saran	6905	5000	11905
2.	Siwan	5127	-	5127
3.	Gopalganj	680	-	680
4.	East Champaran	4500	5860	10360
5.	West Champaran	9590	10780	20370
6.	Muzaffarpur	15722	44270	59992
7.	Vaishali	3283	5000	8283
8.	Sitamarhi	6000	9000	15000
9.	Darbhanga	-	12020	12020
10.	Madhubani	-	9670	9670
11.	Samastipur	7285	10500	17785
12.	Begusarai	5000	8000	13000
13.	Bhagalpur	9020	12290	21310
14.	Saharsa	3582	14640	18222
15.	Purnia	7040	8980	16020
16.	Katihar	7300	15840	23140
17.	Madhepura	3810	5000	8810
18.	Khagaria	3306	3306	3306
19.	Supaul	4360	5000	9360
20.	Araria	5992	5000	10992
21.	Kishanganj	-	8000	8000
22.	Sheohar	-	-	-
North Bihar Plain		**108502**	**194850**	**303352**

Source: Unpublished Data obtained from the Directorate of Food Supplies Department of Bihar, Patna.

over. But it has always been one of the major problems of Indian farmers as well as of study area to safeguard the foodgrains from rodents, insects etc.

The government has setup godowns almost in each district of the study area. During the year 2001, the total storage capacity of foodgrains in the region is recorded 1.085 lakh metric tones excluding the capacity of Food Corporation of India (FCI). Capacity of FCI accounts for 1.948 lakh metric tones, therefore, the total storage capacity of the region is about 3.033 lakh metric tones.

The regional patterns of storage capacity per thousand of population in quintals are shown in Table 5.8 which indicates that it is quite uneven among the districts of the region during 2000-2001. It ranges from 3.163 quintals per thousand of population in Gopalganj to as high as 160.24 quintals in Muzaffarpur followed by Saharsa 120.96 quintals, Katihar 96.84 quintals and Bhagalpur 87.68 quintals per thousand of population. It is evident from the table that West Champaran (66.93), Purnia (63.05), Kishenganj (61.82), Madhepura (57.79), Sitamarhi (56.18), Begusarai (55.48), Supaul (53.64), Samastipur (52.10), Araria (51.73), Saran (36.61) and Darbhanga (36.59) have recorded between 34.26 to 68.85 quintals per thousand populations. Remaining districts have less than 34.26 quintals per thousand populations. These districts are severely deficit in production of foodgrains and depend upon import of foodgrains. The imported foodgrains are stored in godowns for further processes. The existing foodgrains storage facilities in the study area are not adequate to cater the need of the population of the region. The farmers are unable to maintain their own stores and the majority of small farmers dispose of their seasonal surpluses immediately after the harvest to pay their debt and get their other needs fulfilled when the prices are generally low. Some of the farmers store their products with care but the system of storage is not in a position to guarantee the safely from any loss of the food products. Public storage facilities at small places are the need of the hour. The storage facilities are concentrated in urban areas and rural population is not much benefited. There is a need to develop adequate food storage facilities at village and Mandi level. Therefore, the interest of rural population should be protected and food loss may also be minimized, through establishment of adequate storage facilities. Establishment of storage centers at small village

should be given priority in the planning of food security. This type of storage centers can be managed by cooperative societies, which provides an opportunity for public participation in establishing storage centre. The existing storage facilities available at household level for domestic use to minimize the food losses should be encouraged by giving loan through different institutions for the establishment of household storage facilities.

Public Distribution System (PDS)

The Public Distribution System plays an important role in enhancing food security. The PDS in its present is a producer price-support cum consumer subsidy programme evolved in the wake of foodgrains shortages of the 1960's. It has been then confined mainly to urban areas and food deficit areas with an emphasis primarily on price stabilization till the late 1970s. The welfare dimension of the Public Distribution System has gained importance since the early 1980's and its coverage was extended to rural areas in some states as well as to areas with a high incidence of poverty (Radhakrishna, 2002).[9]

Therefore, number of fair price shops per thousand of population is selected as an indicator of food stability. Storage and distribution of foodgrains are two sides of the same coin. Storage centers can be meaningful only if their spatial location and operational facilities help the distribution system of foodgrains.

The North Bihar Plain is not found self-sufficient in foodgrains in 2001. The total annual production is recorded 7.08 million tones of foodgrains, which accounts for availability of 131 kg. per person per annum. In this situation there is a need of an adequate and proper functioning public distribution system in the region.

Table 5.3 indicates that the network of the Public Distribution System is spread in most of the districts of the region with varying intensity, through the Food and Supply Department. The total number of fair price shops in the region is 26,509. The distribution of fair price shops per thousand populations among the districts of the region is not uniform. It varies from 0.22 in Muzaffarpur to 0.78 in Saran. It is followed by Siwan (0.68), Bhagalpur (0.59), Gopalganj (0.58) fair price shops per thousand populations. Five

Table 5.3 Districtwise Number of Fair Price Shops in North Bihar Plain 2001

S.No.	Districts	Urban	Rural	Total
1.	Saran	764	1784	2584
2.	Siwan	551	1285	1836
3.	Gopalganj	376	877	1253
4.	East Champaran	497	1161	1658
5.	West Champaran	564	1317	1881
6.	Muzaffarpur	243	566	809
7.	Vaishali	449	1046	1495
8.	Sitamarhi	345	806	1151
9.	Darbhanga	462	1077	1539
10.	Madhubani	506	1180	1686
11.	Samastipur	445	1037	1482
12.	Begusarai	301	701	1002
13.	Bhagalpur	431	1007	1438
14.	Saharsa	233	544	777
15.	Purnia	320	746	1066
16.	Katihar	301	703	1004
17.	Madhepura	174	405	579
18.	Khagaria	208	486	694
19.	Supaul	217	506	723
20.	Araria	297	693	990
21.	Kishanganj	197	459	656
22.	Sheohar	72	170	242
North Bihar Plain		**7953**	**18556**	**26509**

Source: Unpublished Data obtained from the Directorate of food Supplies Department of Bihar, Patna.

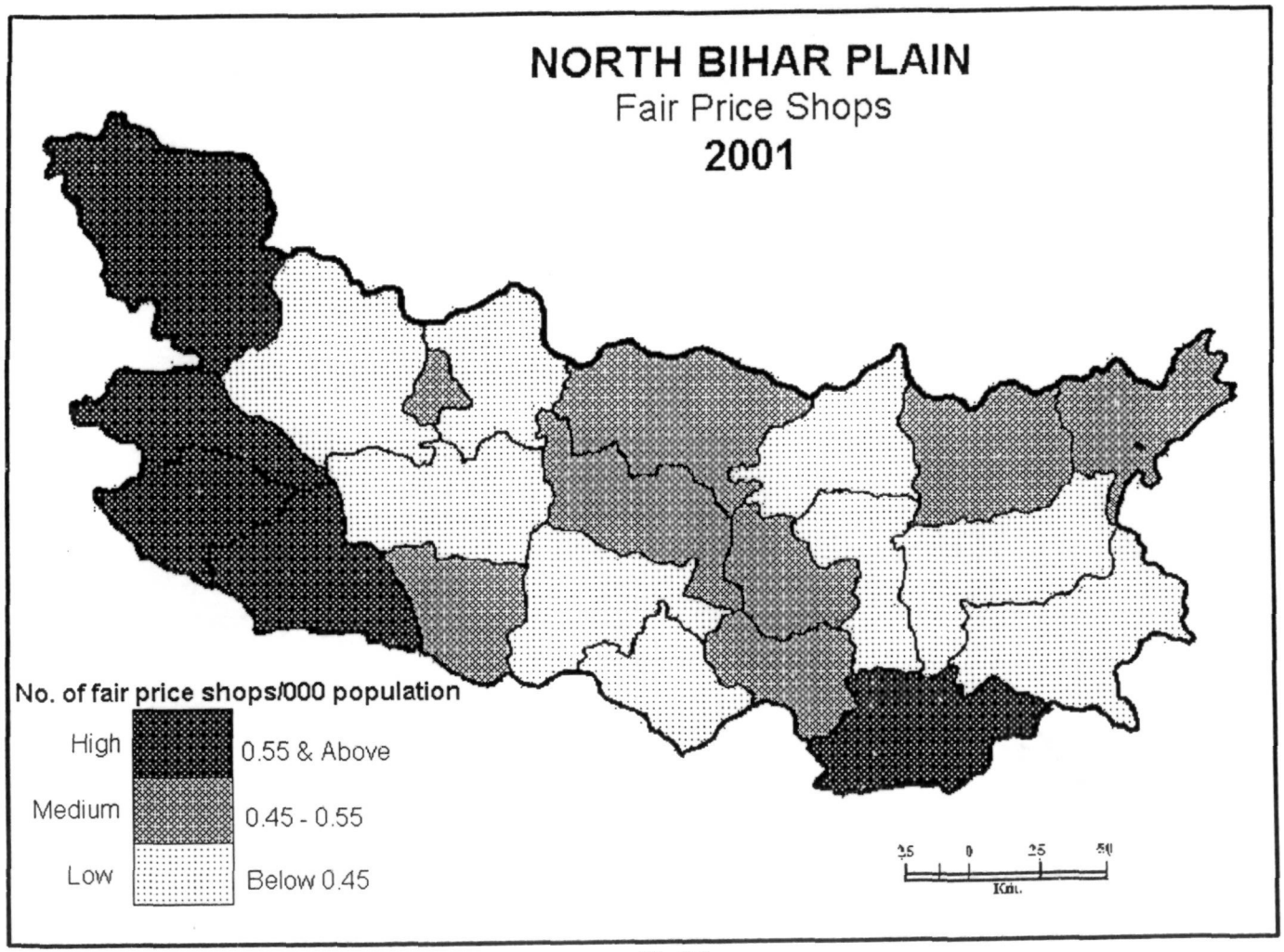

NORTH BIHAR PLAIN
Fair Price Shops
2001
No. of fair price shops/000 population
High
0.55 & Above
Medium
0.45 - 0.55
Low
Below 0.45
25
0
25
50
Km.

Fig.5.6

districts namely, Vaishali (0.55), Saharsa (0.52), Khagaria (0.54), Kishenganj (0.51), Darbhanga (0.47), Madhubani (0.47), Araria (0.47) and Sheohar (0.47) come under the range of 0.45 to 0.55 number of fair price shops per thousand populations. Remaining districts are found below the -0.45 fair price shops per thousand populations.

REGIONAL PATTERNS OF OVERALL FOOD STABILITY

The interdistrict variation in composite Z-scores of the food stability is conveniently arranged into three suitable grades of high (+0.30 and above), medium (-0.30 to + 0.30) and low (below –0.30), Z-scores. Four districts namely, West Champaran, Saran, Siwan and Saharsa emerge under the range of high food stability with composite Z-score of 1.43 and 0.78 respectively. In these districts the concentration of all indicators of food stability is high except storage capacity per 1000 population. Therefore, these districts have been found under high food stability. Fig. 5.7 shows that about half of the districts came under the category of medium food stability. These are Gopalganj, East Champaran, Muzaffarpur, Samastipur, Vaishali, Madhubani, Khagaria, Bhagalpur, Madhepura, Araria, Kishenganj, Purnia and Katihar. These districts spread all over the regions and fall under the range of –0.30 to +0.30 composite Z-score. Remaining districts namely, Sitamarhi, Sheohar, Darbhanga, Begusarai and Supual come under the category of low food stability (below –0.30 composite Z-score values) and found in the north central part of the study area.

DISTRIBUTION OF FOOD ACCESSIBILITY

It is a well-known fact that the question of food security has a number of dimensions that go beyond the production, availability and demand for food. Ultimately, it is a question of the ability to access food for all the people at all times to lead a healthy life. The vast majority of malnourished population cannot produce or afford to buy enough food. They have inadequate access to natural resources, jobs, income or social security (Chaturvedi, 1997).[10] In other words, adequate food supply is not the only condition for ensuring an active and healthy life, if people do not have purchasing power to buy them for their consumption. In the present study,

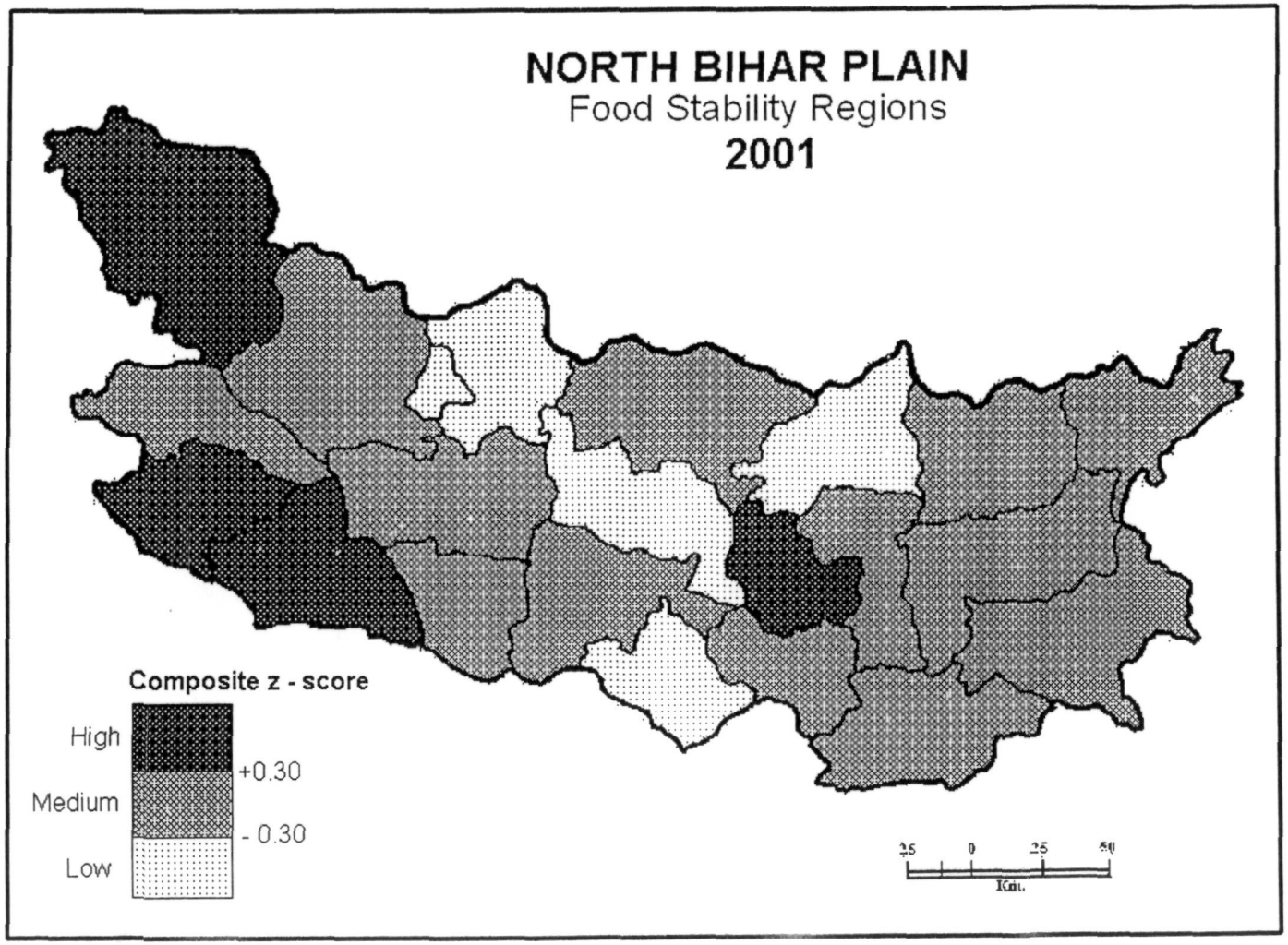

NORTH BIHAR PLAIN
Food Stability Regions
2001
Composite z - score
High
Medium
Low
+0.30
- 0.30
25 0 25 50
Km.

Fig.5.7

food accessibility in the region has been assessed in terms of indicators namely percentage of families above poverty line, literacy rate, main workers to the total population, road density per square kilometer and percentage of urban population to the total population.

Purchasing Power

Purchasing power is the most important indicator of food accessibility. In India, a large number of people are poor and unable to purchase foodstuff of the required quantity and quality. Owing to non availability of data pertaining to per capita income which is one of the most important indicators of purchasing power, the percentage of families above poverty line has been taken as a substitute for per capita income to show food accessibility.

Poverty is the root cause for poor intake and low nutritional level that hinder the development process itself. According to United Nations, a household is food secure when it has access to food needed for a healthy life for all its members (adequate in terms of quality, safety and culturally acceptable) and when it is not at undue risk of losing such access. Most of the qualitative and quantitative indicators of food security at household level are linked to poverty issues. Poor do not have adequate means or entitlements to secure their access to food even when food is available in government bins and local markets. Over the years, India has witnessed a trend of decline in the incidence of poverty. However, the absolute number of poor is still high (around 260 million). Agriculture is the main source of livelihood and income, where more than two thirds of the population is engaged in agriculture and its allied activities. The majority of the poor live in rural areas indicating that poverty in India is mainly a rural phenomenon (Srinivasan, 2002).[11]

The incidence of poverty in Bihar is the highest among the 28 states of India. The Planning Commission estimated that 55 per cent of the population in the state are living below the poverty line in 1993-94 as compared to 36 per cent at all India level and 12 per cent for Punjab. Thus, Bihar is the poorest state in India. The 2001 population Census has reported nearly 92.71 per cent of the people living in rural areas with a rate of growth of population of 2.8 per cent per year. Agriculture is the main occupation in the rural areas;

Table 5.4

Trends of Per Capita Income in India and Bihar 1993-1994 to 2000-2001 (At constant 1993-94 prices)

S. No.	Years	Bihar	India
1.	1993-94	3037	7690
2.	1995-96	2728	8489
3.	1996-97	3338	9007
4.	1997-98	3100	9244
5.	1998-99	3210	9650
6.	1999-2000	3281	10071
7.	2000-01	3879	10313

Source: India 2001, A Reference Annual, Government of India and Directorate of Economics and Statistics 2000-2001, Patna, Government of Bihar.

Table 5.5 Districtwise Families of Above Poverty line (APL) in North Bihar Plain 2001

S.No.	Districts	Total no. of Families	Total APL Families	%age of Families APL
1.	Saran	316863	145432	45.90
2.	Siwan	281051	266769	49.02
3.	Gopalganj	321259	200437	62.39
4.	East Champaran	529034	242944	45.92
5.	West Champaran	536396	282328	52.63
6.	Muzaffarpur	612147	269759	44.07
7.	Vaishali	465796	274418	58.91
8.	Sitamarhi	438401	144125	32.88
9.	Darbhanga	484433	193544	39.95
10.	Madhubani	618106	170411	27.57
11.	Samastipur	521785	184441	35.35
12.	Begusarai	334992	116060	34.64
13.	Bhagalpur	311559	92881	29.81
14.	Saharsa	230000	66493	28.91
15.	Purnia	389984	117136	30.04
16.	Katihar	374984	190766	50.87
17.	Madhepura	226926	101284	44.64
18.	Khagaria	312262	159982	51.23
19.	Supaul	270600	68840	25.44
20.	Araria	395015	77969	19.74
21.	Kishanganj	172522	172484	42.01
22.	Sheohar	76300	23021	30.17
North Bihar Plain		**8220415**	**3332524**	**40.54**

Source: Unpublished Data obtained from the Directorate of Food Supplies Department of Bihar, Patna.

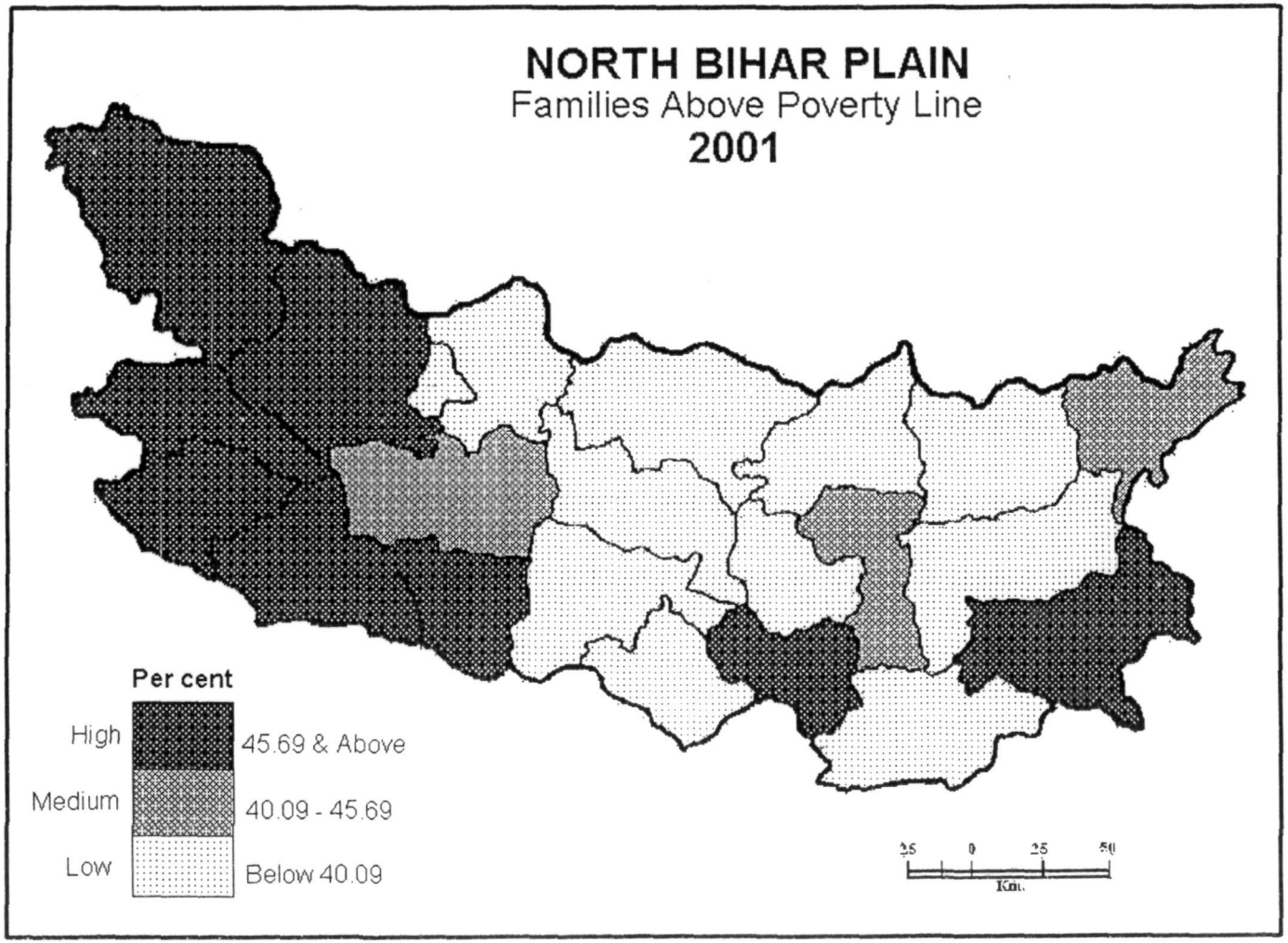

NORTH BIHAR PLAIN
Families Above Poverty Line
2001
Per cent
High
45.69 & Above
Medium
40.09 - 45.69
Low
Below 40.09
25 0 25 50
Km.

Fig.5.8

about79 percent of the working population is directly dependent on agriculture, which contributes 59 per cent to the gross domestic product originating from the state. The per capita net domestic product for 1995-96 is estimated at US $ 100 for Bihar compared with US $ 453 for Punjab, the richest state in India [EPWRE 1998]. Table 5.4 clearly reveals that the per capita income of the population of state is much lower than the national average, which directly affects the purchasing power of the people. Table 5.5 indicates the spatial distribution of population above poverty line.

The distribution of families above poverty line is quite uneven among the districts of North Bihar Plain in year 2001. Arbitrarily three grades are identified to highlight the percentage of families above poverty line (Fig. 5.8). There are eight districts namely, Saran (45.90), Siwan (49.02), Gopalganj (62.39), Vaishali (58.91), West Champaran (52.63), Khagaria (51.23), Katihar (50.87) and East Champaran (45.92), which come under the range of above 45.69 per cent families above poverty line. Districts of Muzaffarpur (44.07), Madhepura (44.64) and Kishenganj (42.01) fall under the range of 40.09-45.69 per cent. Remaining eleven districts which include the districts of Samastipur (35.35), Darbhanga (39.95), Sitamarhi (32.88), Begusarai (34.64), Purnia (30.04), Bhagalpur, (29.81), Saharsa (28.91), Madhubani (27.57), Supual (25.44) and Araria (19.74) are found in category of below 40.09 per cent of families above poverty line and cover the eastern half of the study area.

Employment

Employment is also an important indicator of food accessibility. It refers to the main workers to the total population. Therefore, percentage of the main workers to the total population has been taken as a measure of employment.

The distribution of percentage of main workers to the total population among the districts of North Bihar Plain is shown in the table which varies between 18.90 per cent in Siwan and 32.66 per cent in Madhepura followed by Araria with 30.92 per cent. It may be noted that five districts namely, West Champaran, Supaul, Kishenganj, Purnia and Katihar have reported high percentage of main workers (27.53 per cent and above). All these districts

Table 5.6 Districtwise Distribution of Main workers in North Bihar Plain 2001

S.No.	Districts	Rural	Urban	Total	Working population to the total population
1.	Saran	585569	59049	644618	19.84
2.	Siwan	481295	30283	511578	18.90
3.	Gopalganj	438573	28238	466811	21.73
4.	East Champaran	966918	58736	1025654	26.07
5.	West Champaran	767394	73169	840563	27.62
6.	Muzaffarpur	81449	81338	895830	23.93
7.	Vaishali	584435	40017	624452	23.00
8.	Sitamarhi	676575	37561	714136	26.74
9.	Darbhanga	704932	56532	761464	23.17
10.	Madhubani	849244	28168	877412	24.56
11.	Samastipur	815107	28249	843356	24.70
12.	Begusarai	548085	23479	571564	24.41
13.	Bhagalpur	482426	98305	580731	23.91
14.	Saharsa	385496	26070	411566	27.36
15.	Purnia	730501	51836	782364	30.78
16.	Katihar	616842	47417	664259	27.78
17.	Madhepura	481994	16373	498367	32.66
18.	Khagaria	315829	17433	333262	26.08
19.	Supaul	504667	21600	526267	30.14
20.	Araria	624459	32987	657446	30.92
21.	Kishanganj	327315	32504	359819	27.82
22.	Sheohar	128369	4979	133348	25.88
North Bihar Plain		**12830517**	**894350**	**13724867**	**25.34**

Source: Census of India 2001, Series-I, Primary Census Abstract total population: Table A-5, registrar general and census commissioner, India

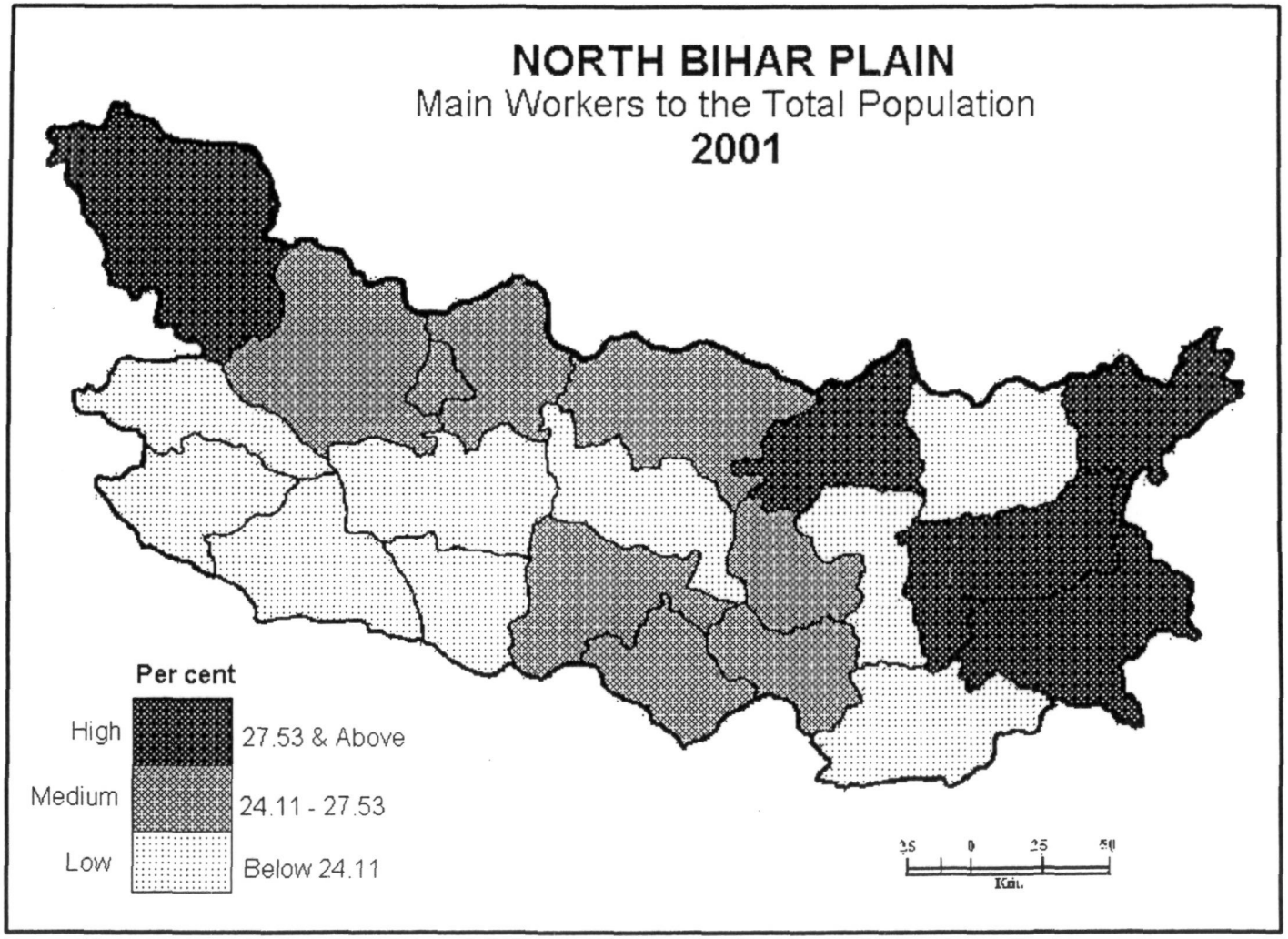

NORTH BIHAR PLAIN
Main Workers to the Total Population
2001
Per cent
High
27.53 & Above
Medium
24.11 - 27.53
Low
Below 24.11
25 0 25 50
Km.

Fig.5.9

constitute a compact block in the north east except West Champaran which covers the north western part of the study area. Eight districts namely, East Champaran, Sheohar, Sitamarhi, Madhubani, Samastipur, Saharsa, Begusarai and Khagaria fall under the range of 24.11 to 27.53 per cent of employment and they form two isolated tracts in north and south. Remaining districts record less than 24.11 per cent of employment (Fig. 5.9).

Literacy Rate

Literacy rate forms an important demographic element and is a good measure of overall development and access of food. Poverty and illiteracy are the root cause of food insecurity in India. Most of the studies show that literacy plays an important role for the removal of poverty, control of population growth and to secure food.

The interdistrict range of variations in literacy rates shows that the percentage of literacy varies between 27.99 per cent in East Champaran to 52.01 per cent in Saran and Siwan districts during the year 2001. Four districts such as Saran and Siwan (52.01), Vaishali and Bhagalpur (50.28) fall under the grade of high literacy rate (50 per cent and above) as shown in Fig. 5.10 and Table 5.8. Districts of Begusarai (48.55), Gopalganj (48.19), Muzaffarpur (48.15), Samastipur (45.76), Darbhanga (44.32), Madhubani (42.35) and Khagaria (41.56) fall under medium category of literacy. Remaining districts namely, East Champaran, West Champaran, Sitamarhi, Saharsa, Purnia, Katihar, Madhepura, Supaul, Araria, Kishenganj and Sheohar recorded less than 40 per cent of literacy rate and categorized among low literacy rate.

Road Length

Road length is also considered as an important indicator of food accessibility. Expansion and improvement of the transport network, especially rural roads, has made easier and cheaper for farmers to access agricultural inputs and market their produce. Therefore, road density per square km area has been taken as a measure of food accessibility. The distribution of roads density among the districts of North Bihar Plain is dissimilar. It varies between 0.001 km/sq. in East Champaran to 0.49 km/sq. in Darbhanga. Only

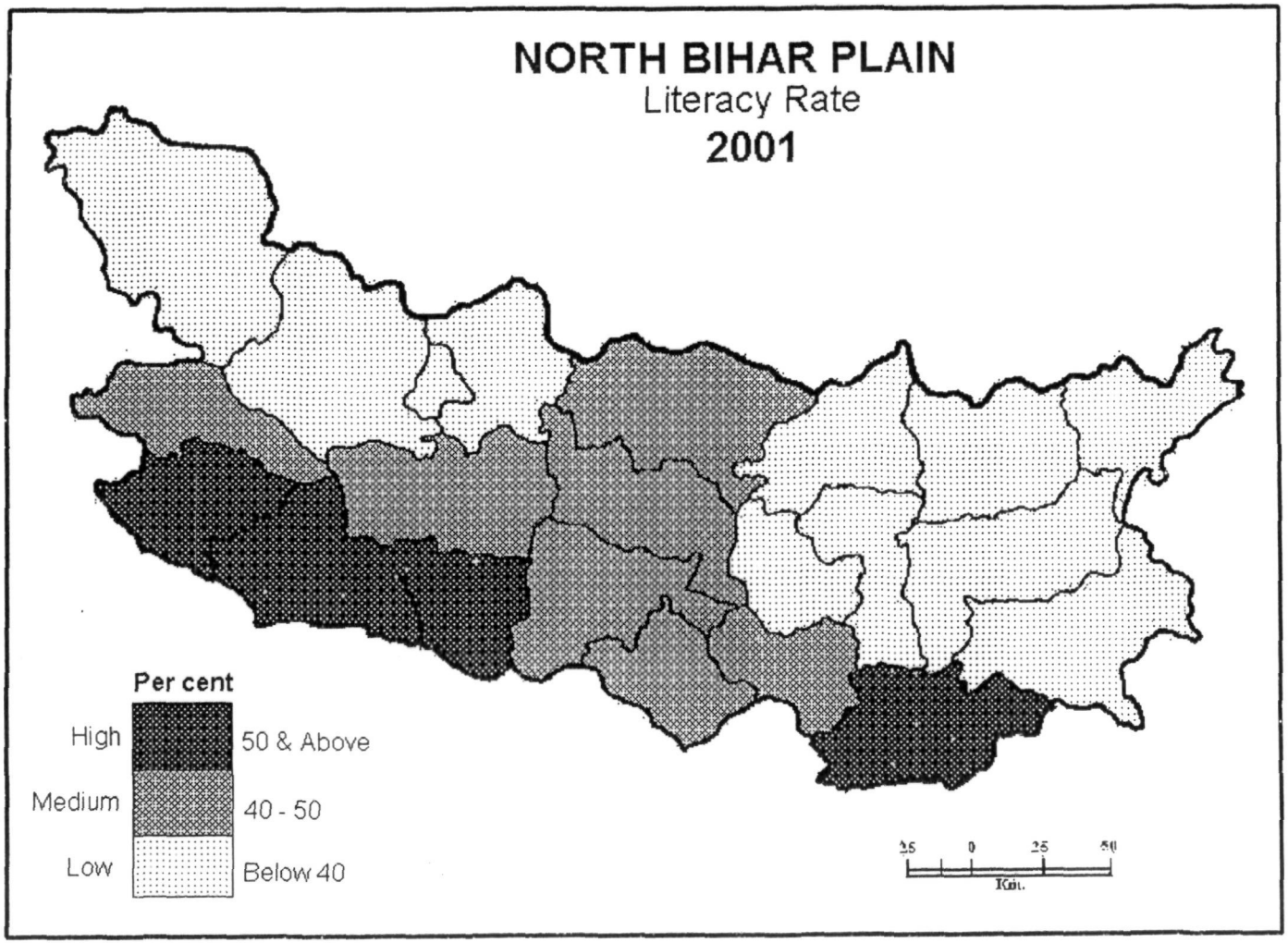

NORTH BIHAR PLAIN
Literacy Rate
2001
Per cent
High
50 & Above
Medium
40 - 50
Low
Below 40
25 0 25 50
Kms.

Fig.5.10

Table 5.7 Districtwise Road Length (in km) in North Bihar Plain 2001

S.No.	Districts	Surfaced Road	Unsurfaced Road	Total Road Length	Road Density/km^2
1.	Saran	60.0	68.00	128.00	0.05
2.	Siwan	17.00	11.00	28.00	0.01
3.	Gopalganj	28.00	8.00	36.00	0.02
4.	East Champaran	2.00	6.00	8.00	0.0019
5.	West Champaran	25.00	52.00	77.00	0.018
6.	Muzaffarpur	110.00	15.00	125.00	0.04
7.	Vaishali	7.00	4.00	11.00	0.005
8.	Sitamarhi	14.00	15.00	29.00	0.011
9.	Darbhanga	11.26	-	1226.00	0.49
10.	Madhubani	26.00	36.00	62.00	0.017
11.	Samastipur	18.00	6.00	24.00	0.009
12.	Begusarai	29.00	2.00	31.00	0.016
13.	Bhagalpur	92.00	71.00	163.00	0.065
14.	Saharsa	45.00	30.00	75.00	0.062
15.	Purnia	112.00	130.00	242.00	0.075
16.	Katihar	38.00	25.00	63.00	0.02
17.	Madhepura	16.00	25.00	41.00	0.023
18.	Khagaria	15.00	5.00	20.00	0.013
19.	Supaul	14.00	15.00	29.00	0.009
20.	Araria	35.00	50.00	85.00	0.03
21.	Kishanganj	22.00	36.00	58.00	0.029
22.	Sheohar	2.00	2.00	4.00	0.009
North Bihar Plain		**1953**	**612**	**2565**	**0.047**

Source:Official Records of Directorate of Statistics and Evaluation, Bihar, Patna

Gopalganj fall under the low density of road length while Darbhanga has the highest road density to the geographical area and remaining districts fall under medium category of road density, ranging between 0.002 to 0.094 km/sq as shown in Table 5.7.

Urbanization

Urbanization is also considered as one of the important indicators of food accessibility. It is observed that urban population has more access to food than their rural counterparts. People migrate from rural areas to urban centers because of the scope for job opportunities and better facilities such as health, education and infrastructure and also energy a better mallets of life. Table 5.8 reveals that the interdistrict percentage of urban population to the total population which varies from 0.01 per cent in Sheohar to 11.46 per cent in Bhagalpur followed by West Champaran with 8.82 per cent. There are six districts namely Saran, East Champaran, West Champaran, Muzaffarpur, Darbhanga and Bhagalpur which fall under the high levels of urbanization (5.85 per cent and above). Medium levels of urbanization are found in Siwan, Gopalganj, Vaishali, Sitamari, Purnia, Katihar, Araria and Kishenganj. Remaining districts namely Madhubani, Samastipur, Begusarai, Saharsa, Madhepura, Khagaria, Supaul and Sheohar record low levels of urbanization (below 3.23).

REGIONAL PATTERNS OF OVERALL FOOD ACCESSIBILITY

In order to identify food accessibility regions for the year 2001, in the study area, districtwise Z-scores of five indicators as noted above is calculated separately and then the composite Z-scores are worked out as shown in Table 5.10. The inerdistrict variations in the composite values of Z-scores are found in the range of –0.720 in Sheohar to +0.985 in Saran. The district level Z-scores are arranged into three grades of high (+0.43 and above), medium (+0.43 to –0.43) and low (below –0.43) food accessibility. Fig. 5.12 reveals that five districts of North Bihar Plain including Saran (+0.985), West Champaran (+0.456), Muzaffarpur (+0.433), Darbhanga (+0.824) and Bhagalpur (+0.486) fall under the grade of high food accessibility (+0.43 composite Z-score and above). The majority of the

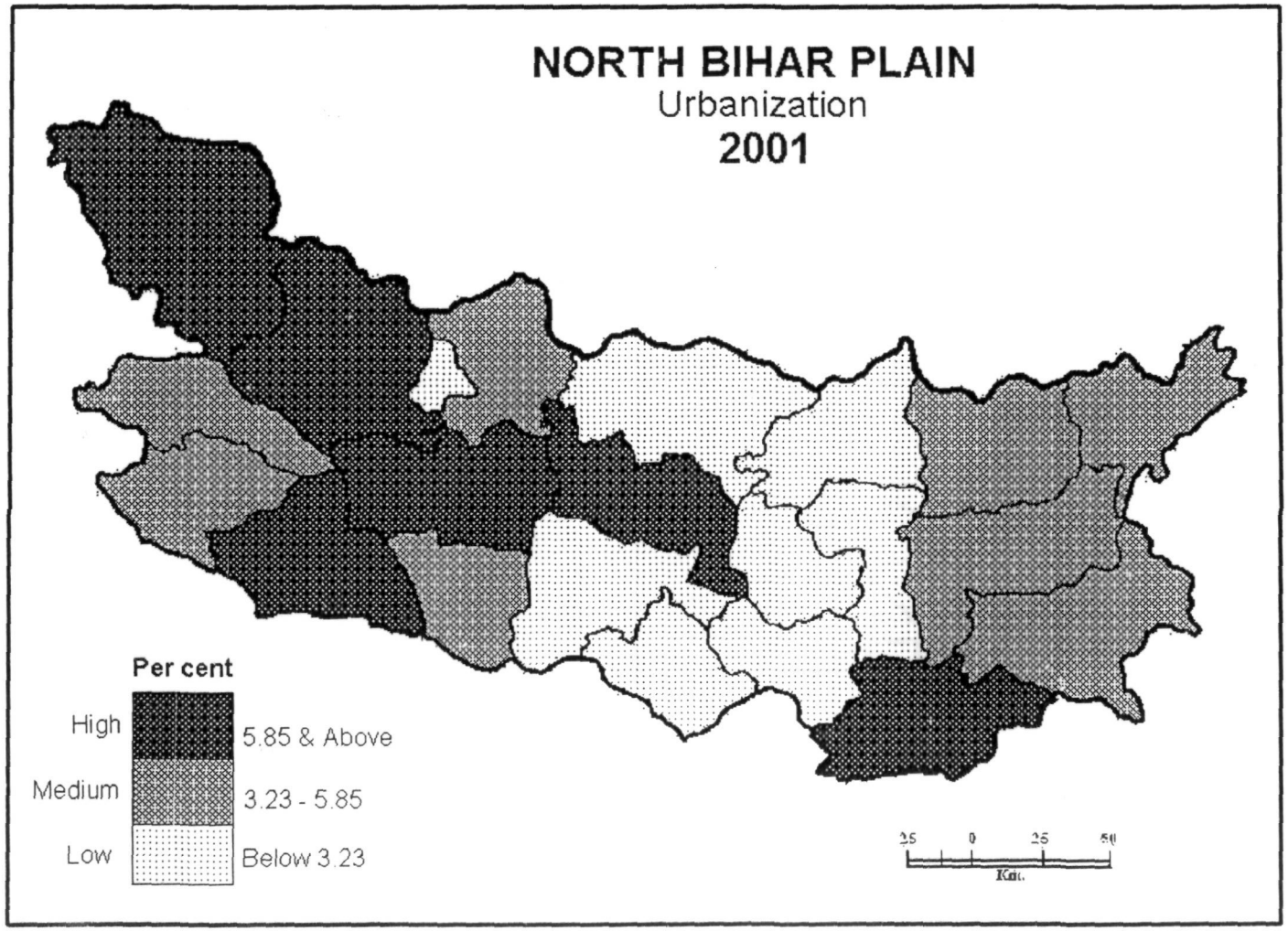

NORTH BIHAR PLAIN
Urbanization
2001
Per cent
High
5.85 & Above
Medium
3.23 - 5.85
Low
Below 3.23
25
0
25
50
Km.

Fig.5.11

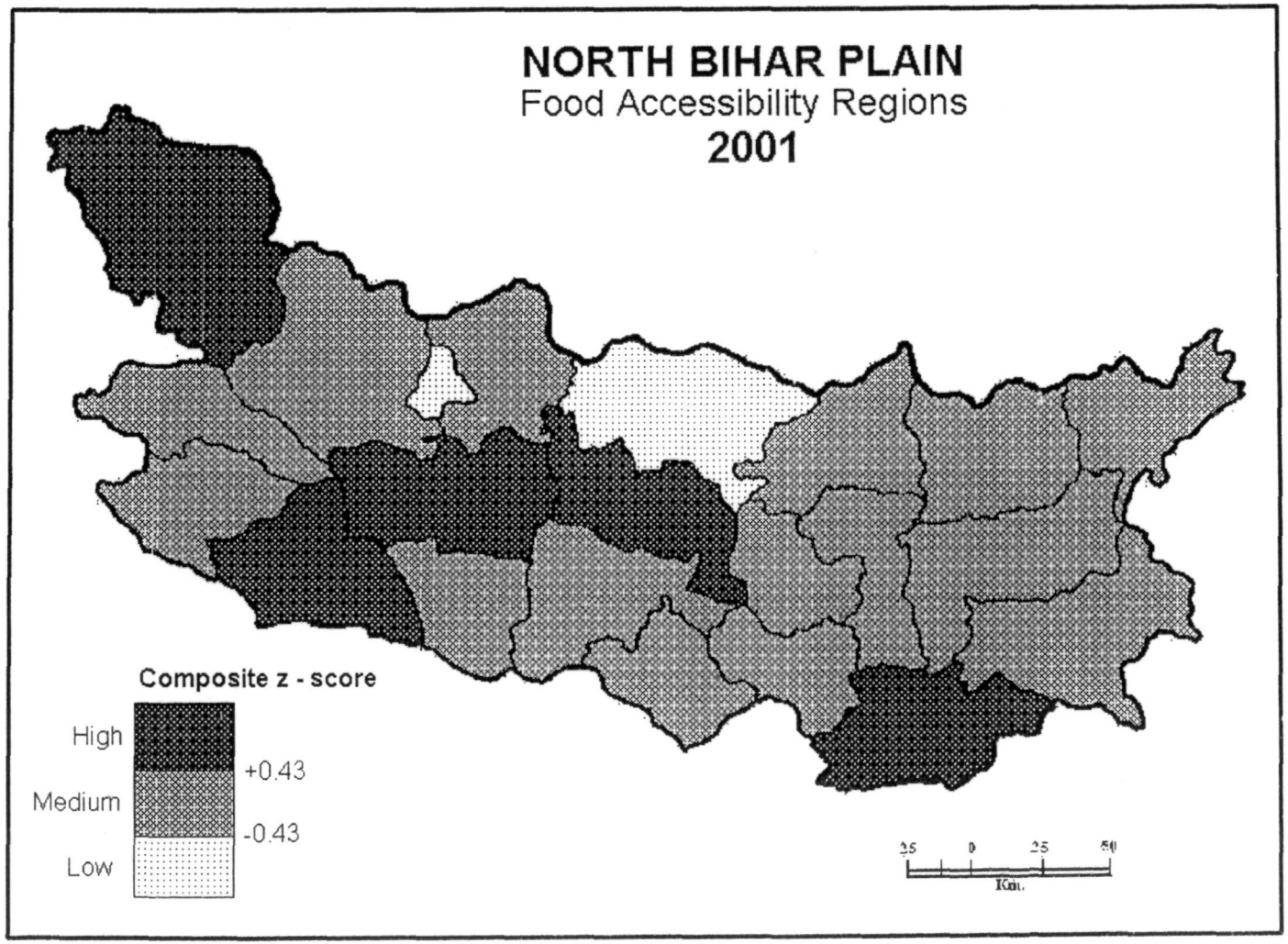

NORTH BIHAR PLAIN
Food Accessibility Regions
2001
Composite z - score
High
Medium
Low
+0.43
-0.43
25
0
25
50
Km.

Fig.5.12

districts namely, Siwan(-0.99), Gopalganj(0.167), East Champaran(-0.230), Vaishali(0.354), Sitamarhi(-0.269), Samastipur(-0.062), Begusarai(-0.195), Saharsa(-0.002), Purnia(0.050), Katihar(0.129),Madhepura(0.046), Khagaria (-0.071), Supaul(-0.375), Araria(0.165) and Kishenganj(-0.299) come under the grade of medium (-0.43 to +0.43 composite Z-score values) food accessibility and covers a large area of the study region. Remaining districts of Madhubani (-0.452) and Sheohar (-0.720) are found under the low ranges of food accessibility (below –0.43 composite Z-scores).

FOOD SECURITY REGIONS

The foregoing analysis clearly reveals that there are a lot of variations in the levels of food availability, food stability and food accessibility among various districts of the region. There are some districts which have high scores with respect to certain indictors but low in other indicators. In order to assess overall food security, Z-scores of eight indictors two of food availability, three of food stability and five of food accessibility are calculated districtwise as shown in Table 5.10 and they are added districtwise and the average is obtained to find out composite Z-scores of food security. Table 5.10 shows that districtwise variations of Z-scores varies between (+1.003) and (-0.725) with a maximum in West Champaran and a minimum in Sheohar.

The regional pattern of food security shows that six districts namely, Saran, West Champaran, Gopalganj, Madhepura, Khagaria and Bhagalpur fell under the category of high food security (+0.25 and above), former three districts lie in the west and remaining districts are located in the east of the region. Table 5.10 reveals that out of ten indicators eight contributed positive values in West Champaran, Seven in Khagaria, six in Madhepura, Saran, Gopalganj, and Bhagalpur. Therefore, these districts record high food security. In West Champaran, the indicators like caloric availability per head per day, production of foodgrains in kg. per head per annum, yield of foodgrains in kg.per hectare, number of fair price shops per 1000 populations, percentage of families above poverty line and urbanization recorded very high values of Z-scores.

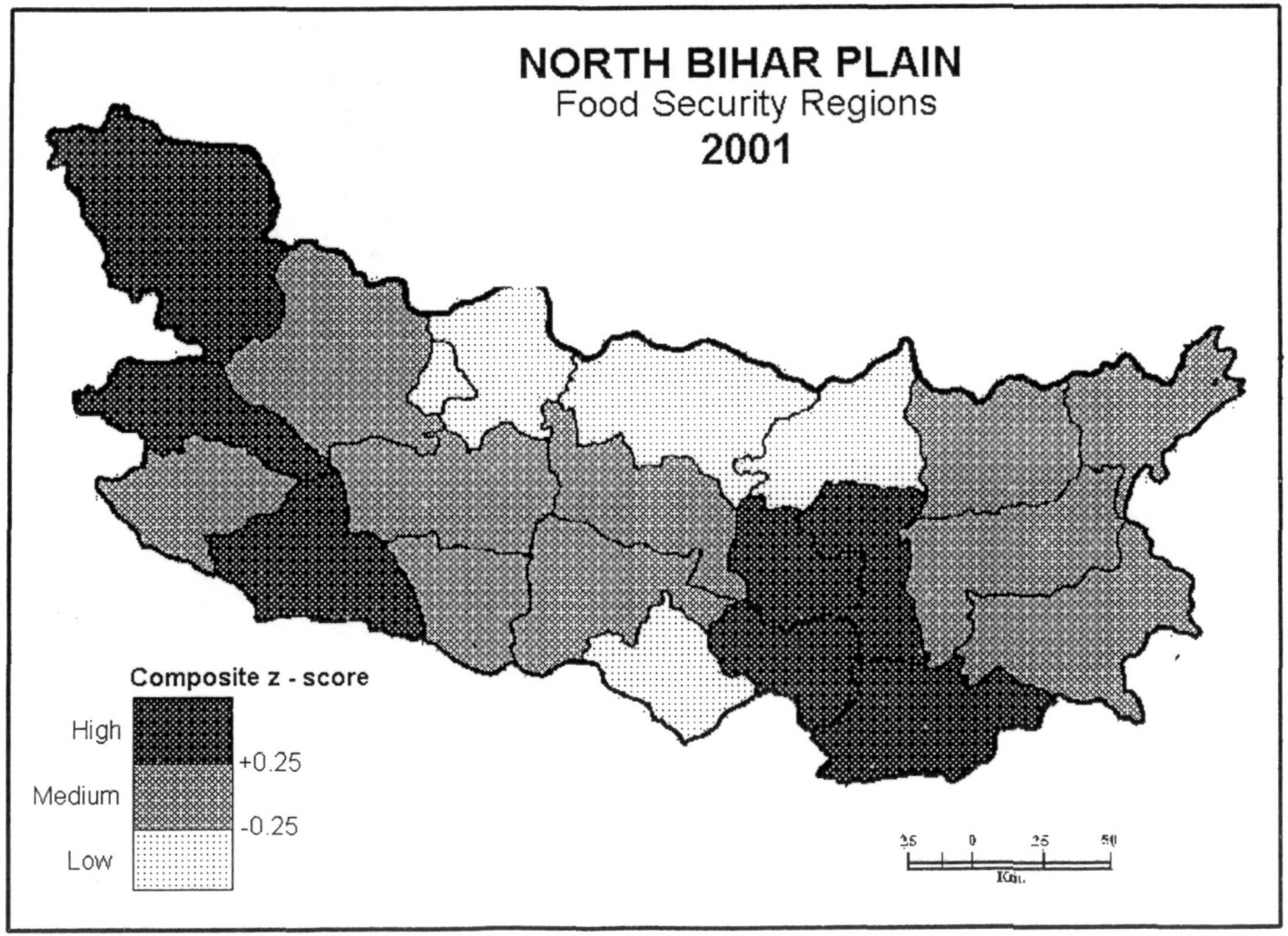

NORTH BIHAR PLAIN
Food Security Regions
2001
Composite z - score
High
Medium
Low
+0.25
-0.25
25 0 25 50
Kms.

Fig.5.13

Table 5.8 Districtwise Distribution of Food Availability, Food Stability and Food Accessibility by Indicators in North Bihar Plain 2001

S. No.	Districts	Food Availability		Food Stability			Food Accessibility				
		Caloric availability per head per day	Production of foodgrains in kg per head per annum	Yield of foodgrains (in kg per hectare)	Storage capacity per 1000 pop. (in quintals)	No. of fair price shops per 1000 population	Percentage of families above poverty line	Percentage of literacy	Percentage of main workers to the total population	Road density /km2	Urbanization
1.	Saran	1650	127	1898	36.61	0.78	45.90	52.01	19.84	0.05	7.54
2.	Siwan	2108	172	2085	18.92	0.68	49.02	52.01	18.90	0.00	3.74
3.	Gopalganj	2566	188	2118	3.16	0.58	62.39	48.19	21.73	0.02	3.30
4.	East Champaran	2533	179	2380	26.33	0.42	45.92	27.99	26.07	0.01	6.38
5.	West Champaran	3200	203	3051	66.93	0.62	52.63	39.63	27.62	0.02	7.85
6.	Muzaffarpur	1882	119	1851	160.24	0.22	44.07	48.15	23.93	0.04	8.82
7.	Vaishali	1500	102	2060	30.53	0.55	58.91	51.63	23.00	0.01	4.73
8.	Sitamarhi	1439	195	1569	56.18	0.43	32.88	39.38	26.74	0.01	3.89
9.	Darbhanga	2199	71	1599	36.58	0.47	39.95	44.32	23.17	0.49	6.75
10.	Madhubani	1394	95	2345	27.08	0.47	27.57	42.35	24.56	0.02	3.14
11.	Samastipur	1993	107	2160	52.10	0.43	35.35	45.76	24.70	0.01	3.12
12.	Begusarai	1986	116	1402	55.48	0.43	34.64	48.55	24.41	0.02	2.73
13.	Bhagalpur	1462	107	1337	87.68	0.59	29.81	50.28	23.91	0.07	11.46
14.	Saharsa	2094	240	1917	120.96	0.52	28.91	39.28	27.36	27.36	3.14
15.	Purnia	2326	132	1635	63.05	0.42	30.04	35.51	30.78	0.08	5.63
16.	Katihar	2002	141	1599	96.84	0.42	50.87	35.29	27.78	0.02	5.52
17.	Madhepura	2639	203	2148	57.79	0.38	44.64	36.19	32.66	0.02	1.72
18.	Khagaria	2583	222	2163	25.90	0.54	51.23	41.56	26.08	0.01	1.94
19.	Supaul	2379	152	1406	53.64	0.41	25.44	37.8	30.14	0.01	2.22
20.	Araria	2249	152	1639	51.73	0.47	19.74	34.94	30.92	0.03	3.36
21.	Kishenganj	2549	221	1619	61.82	0.51	42.01	31.02	27.82	0.03	3.28
22.	Sheohar	1468	105	1184	0.00	0.47	30.17	37.01	25.88	0.01	0.01

Source: Calculation is based on data obtained from the Census of India 2001. Provisional Population Totals Series Bihar Census of India 2001. Paper III. Unpublished Data obtained from the Directorate of Food and Supplies, Bihar

Table 5.9 Districtwise Distribution of Food Availability, Food Stability and Food Accessibility (in Z-scores) in North Bihar Plain 2001

S. No.	Districts	Food Availability		Food Stability			Food Accessibility				
		Caloric availability per head per day	Production of foodgrains in kg. per head per annum	Yield of foodgrains (in kg. per hectare)	Storage capacity per 1000 pop. (in quintals)	No. of fair price shops per 1000 population	Percentage of families above poverty line	Percentage of Literacy	Percentage of Main Workers	Road density / km^2	Urbanization
1.	Saran	−0.932	−0.423	0.068	−0.418	2.416	0.506	1.448	1.748	−0.085	1.14
2.	Siwan	0.016	0.498	0.514	−0.914	1.583	0.779	1.448	−2.023	−0.398	−0.304
3.	Gopalganj	0.966	0.826	0.593	−1.356	0.750	1.945	0.908	−1.195	−0.351	−0.471
4.	East Champaran	0.897	0.642	1.219	−0.706	−0.583	0.508	−1.949	0.073	−0.484	0.699
5.	West Champaran	2.280	1.134	2.821	0.431	1.083	1.094	−0.302	0.526	−0.351	1.258
6.	Muzaffarpur	−0.451	+0.587	-0.044	3.046	−2.250	0.347	0.902	−0.552	−0.156	1.627
7.	Vaishali	−1.243	+0.936	0.454	−0.588	0.500	1.642	1.394	−0.884	−0.453	0.072
8.	Sitamarhi	−1.370	−1.079	-0.717	0.129	−0.500	−0.629	−0.338	0.269	−0.406	−0.247
9.	Darbhanga	0.205	−0.936	-0.646	−0.419	−0.166	−0.012	0.360	−0.774	3.710	0.840
10.	Madhubani	−1.463	−1.079	1.135	−0.685	−0.166	−1.092	0.082	−0.368	−0.351	−0.532
11.	Samastipur	−0.221	−0.833	0.695	0.015	−0.500	−0.413	0.564	−0.327	−0.421	−0.539
12.	Begusarai	−0.236	−0.649	-1.116	0.110	−0.500	−0.474	0.958	−0.412	−0.359	−0.688
13.	Bhagalpur	01.322	−0.833	-1.271	1.012	0.833	−0.897	1.203	−0.558	0.054	2.631
14.	Saharsa	−0.012	+0.649	0.113	1.945	0.250	−0.975	−0.352	0.450	0.359	0.532
15.	Purnia	0.468	−0.833	-0.560	0.322	−0.583	−0.876	−0.885	1.450	0.148	0.414
16.	Katihar	−0.203	−0.136	-0.646	1.269	−0.583	0.940	−0.916	0.573	−0.320	0.372
17.	Madhepura	1.117	1.734	0.593	0.174	−0.916	0.397	−0.789	2.000	−0.304	−1.072
18.	Khagaria	1.001	1.523	0.700	−0.718	0.416	0.972	−0.029	0.076	−0.390	−0.988
19.	Supaul	0.578	0.088	-1.106	0.058	−0.666	−1.278	−0.561	1.263	−0.421	−0.882
20.	Araria	0.308	0.088	-0.550	0.005	−0.166	−1.775	−0.966	1.491	2.078	−0.448
21.	Kishenganj	0.930	1.503	-0.598	0.287	+0.166	0.167	−1.520	0.584	−0.250	-0.479
22.	Sheohar	−1.310	−0.874	-1.637	–	0.166	−0.865	−0.673	0.017	−0.359	−1.722

Calculation is based on Table 5.8

Table 5.10 Districtwise Food Availability, Food Stability, Food Accessibility and Food Security by Composite Z-Scores 2001

S.No.	Districts	Food Availability	Food Stability	Food Accessibility	Food Security
1.	Saran	-0.675	0.688	0.985	0.732
2.	Siwan	0.255	0.395	-0.099	0.119
3.	Gopalganj	0.898	-0.163	0.167	0.261
4.	East Champaran	0.765	0.020	-0.230	0.031
5.	West Champaran	1.705	1.450	0.456	1.003
6.	Muzaffarpur	-0.518	0.250	0.433	0.198
7.	Vaishali	-1.088	0.123	0.354	-0.004
8.	Sitamarhi	-1.224	-0.364	-0.269	-0.488
9.	Darbhanga	0.685	-0.137	0.824	0.216
10.	Madhubani	-1.269	0.208	-0.452	-0.451
11.	Samastipur	-0.525	0.071	-0.062	-0.115
12.	Begusarai	-0.440	-0.505	-0.195	-0.336
13.	Bhagalpur	-1.075	0.188	0.486	0.349
14.	Saharsa	0.940	0.769	-0.002	0.166
15.	Purnia	0.070	-0.275	0.050	-0.093
16.	Katihar	-0.168	0.011	0.129	0.035
17.	Madhepura	1.120	-0.048	0.046	0.274
18.	Khagaria	1.260	0.134	-0.071	0.256
19.	Supaul	0.330	-0.574	-0.375	-0.292
20.	Araria	0.198	-0.238	0.165	0.051
21.	Kishanganj	1.215	-0.049	-0.299	0.045
22.	Sheohar	-1.090	-0.601	-0.720	-0.725

Calculation is based on Table 5.8

Table 5.10 highlights that eleven out of the twenty two districts namely, Siwan, Samastipur, East Champaran, Muzaffarpur, Vaishali, Darbhanga, Kishenganj, Saharsa, Katihar, Purnia and Araria come under the category of moderate food security (+ 0.25 to –0.25). Former seven districts cover a large area, in the western part of the study region while remaining districts formed a compact block and located in the east. Fig 5.13 shows that four districts of low food security out of five form a contiguous region in the north central part of the study region. They are Sheohar, Sitamarhi, Madhubani and Supaul while, Begusarai located in the south central part.

REFERENCES

1. Chaturvedi, R. (ed.) (1997): Food Security and Punchayati Raj, Concept. Publication, New Delhi.
2. Ghosh, G.N. (2000): Food Insecurity, the Greatest Challenge of the Millennium, *Indian Farming,* Vol. 50, No.7, pp. 7-9.
3. Ibid, p.7
4. Vyas, V.S. (2000): Ensuring Food Security, the State, Market and Civil Society, *Economic and Political Weekly*, Vol. 35, No. 50, p. 4403.
5. Mitra, and Mukherji (1980): Population Food and Land Inequality in India A Geography of Hunger and Insecurity, Allied Publishers, Bombay.
6. Gopalan, C., et. al. (1966): The Nutritive value of Indian Foods and Planning of Satisfactory, Diet, Indian Council of Medical Research, New Delhi.
7. Kravdal, O. (2001): Has Population Growth Restricted Improvement in Food Availability per head 1970-95? Population Studies, Britain, Vol. 55, No. 2, pp. 105-117.
8. Adige, S.R. (1974), Report on Agricultural Census, Bihar, Patna, p. 113.
9. Radhakrishna, R. (2002): Food and Nutrition Security, In Parikh K.S. and Radhakrishna, R. (eds.), *India Development Report*, Oxford University Press, pp. 47-58.
10. Chaturvedi, R. (ed.) (1997): Food Security and Punchayati Raj, Concept Publication, New Delhi, p.268.
11. Srinivasan, P.V. (2002): Poverty an Agricultural Research, in Parikh K.S. and Radhakrishna, R. (eds.) *India Development Report*, Oxford University Press, p. 74.

Chapter VI

AGRICULTURAL DEVELOPMENT VIS-À-VIS FOOD SECURITY REGIONS

In the present chapter an attempt has been made to examine the food security in relation to agricultural development in North Bihar Plain. In order to achieve this objective district wise composite mean Z-scores of agricultural development and food availability, food stability, food accessibility and overall food security have been computed. On the basis of calculated Z- scores maps have been prepared. Map of agricultural development is superimposed with overall food security and its component i.e. availability, stability and accessibility. With the help of correlation matrix, the relationships among the variables of agricultural development and food security have been established. The results of the relationship of agricultural development and food security have also been verified by Regression line.

Agricultural Development and Food Availability Regions

The regional patterns of agricultural development and food availability is depicted in superimposed map (Fig.6.1) which shows that four districts namely, West Champaran, Gopalganj, Khagaria and Madheapura have emerged under the region of both high agricultural development and food availability. The former two form a small contiguous region in the northwestern part of the study region, while latter two districts are found in the central southern part. Only one district of Supaul coincided with medium level of agricultural development and food availability. Three districts namely, Madhubani, Sitamarhi and Sheohar which are located in the extreme central north correspond to the same category of low agricultural development and low food availability. A cursory look of Fig. 6.1 reveals that out of twenty two districts only eight districts coincide with the corresponding categories of agricultural development and food availability.

There is only one district of Kishenganj which records high level of agricultural development but it is found in the category of low level of food availability. Similarly, three districts namely, Araria, Purnia and Katihar are

Table 6.1 Districtwise Agricultural Development ,Food Availability, Food Stability, Food Accessibility and Food Security by Composite Z-Scores, 2001

S. No.	Districts	levels of Agricultural Development	Food Availability	Food Stability	Food Accessibility	Food Security
1.	Saran	0.281	-0.675	0.688	0.985	0.732
2.	Siwan	0.390	0.255	0.395	-0.099	0.119
3.	Gopalganj	0.484	0.898	-0.163	0.167	0.261
4.	East Champaran	0.166	0.765	0.020	-0.230	0.031
5.	West Champaran	0.407	1.705	1.450	0.456	1.003
6.	Muzaffarpur	0.340	-0.518	0.250	0.433	0.198
7.	Vaishali	0.123	-1.088	0.123	0.354	-0.004
8.	Sitamarhi	-0.410	-1.224	-0.364	-0.269	-0.488
9.	Darbhanga	0.388	0.685	-0.137	0.824	0.216
10.	Madhubani	-0.461	-1.269	0.208	-0.452	-0.451
11.	Samastipur	0.202	-0.525	0.071	-0.062	-0.115
12.	Begusarai	1.009	-0.440	-0.505	-0.195	-0.336
13.	Bhagalpur	0.293	-1.075	0.188	0.486	0.349
14.	Saharsa	-0.092	0.940	0.769	-0.002	0.166
15.	Purnia	-0.562	0.070	-0.275	0.050	-0.093
16.	Katihar	-0.371	-0.168	0.011	0.129	0.035
17.	Madhepura	0.275	1.120	-0.048	0.046	0.274
18.	Khagaria	0.542	1.260	0.134	-0.071	0.256
19.	Supaul	-0.050	0.330	-0.574	-0.375	-0.292
20.	Araria	-0.387	0.198	-0.238	0.165	0.051
21.	Kishenganj	-0.705	1.215	-0.049	-0.299	0.045
22.	Sheohar	-0.391	-1.090	-0.601	-0.720	-0.725

Calculation is based on Table 4.5 and 5.8

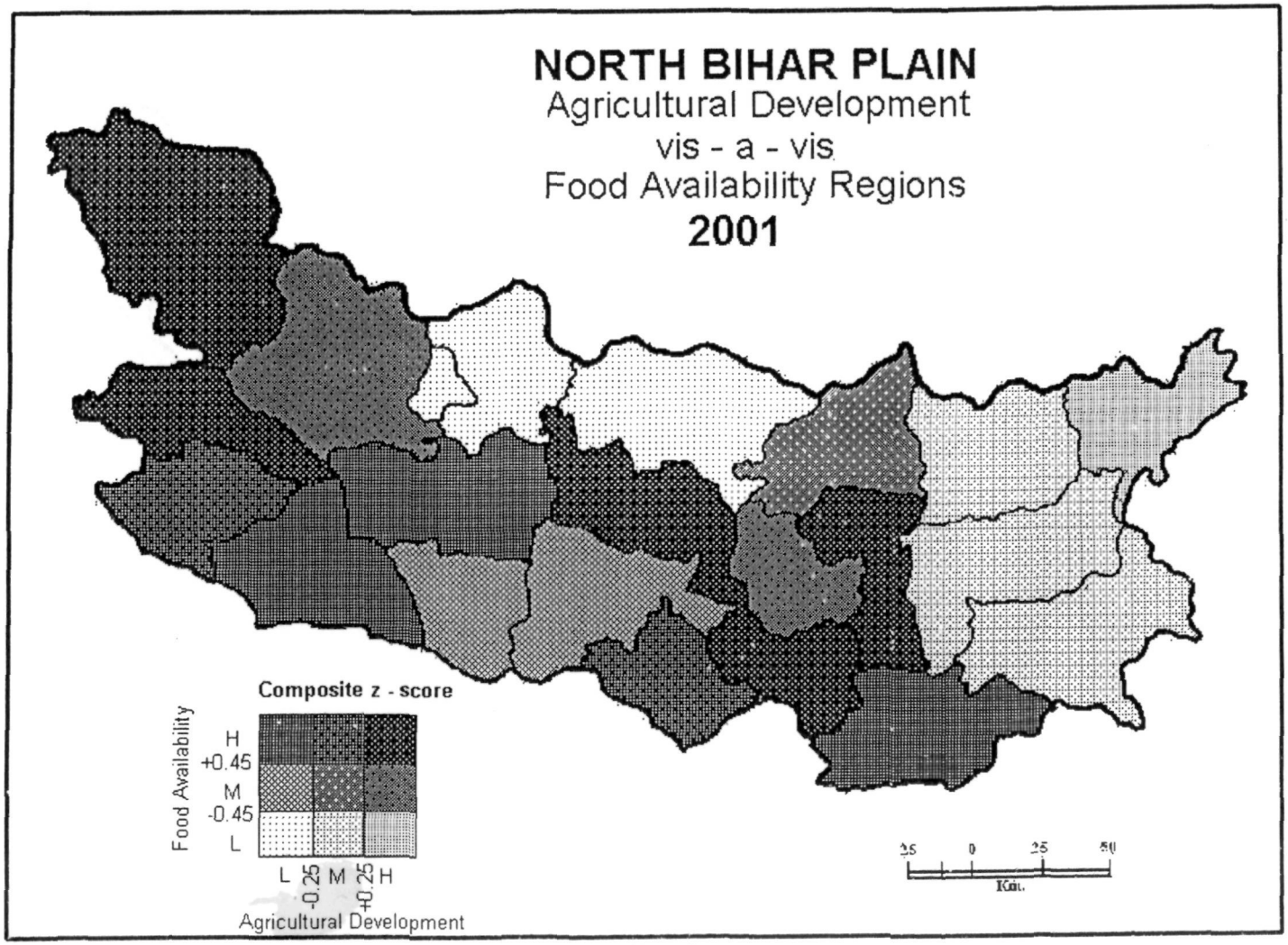

NORTH BIHAR PLAIN
Agricultural Development
vis - a - vis
Food Availability Regions
2001
Composite z - score
Food Availability
H
+0.45
M
-0.45
L
L
-0.25
M
+0.25
H
Agricultural Development
25
0
25
50
Km.

Fig.6.1

under medium level of agricultural development yet found in low level of food security. These are located in the eastern part of the study area.

Agricultural Development and Food Stability Regions

The regions of agricultural development in relation to food stability are shown in Fig.6.2. This highlights that districts of Saran, Siwan and West Champaran emerge under the grade of high agricultural development and high composite index of food stability. The districts namely, Gopalganj, Muzaffarpur, Darbhanga, Khagaria, Madhepura and Bhagalpur fall under the range of high level of agricultural development and medium food stability index. The district of Begusarai belongs to the range of high agricultural development and low food stability index. Medium agricultural development and medium food stability is observed in three districts namely, East Champaran, Vaishali and Samastipur. Two distrcts Sitamarhi and Sheohar have been found in the same category of low agricultural development and low food stability. Five districts have been reported under medium level of agricultural development but low level of food stability. These include the districts of Araria, Katihar, Kishenganj, Purnia and Madhubani. Out of these former four make a notable region in the extreme east whereas later on is found isolated in the central north of the study area. Only one district of Saharsa is found under the category of high level of agricultural development but medium level of food stability.

Agricultural Development and Food Accessibility Regions

The interdistrict variation in the food accessibility in relation to agricultural development is shown in Fig.6.3. Five districts of East Champaran, Vaishali, Samastipur, Saharsa and Supaul are reported under medium agricultural development and medium index of food accessibility. Five districts coincide with high level of agricultural development and high food accessibility. These include West Champaran, Saran, Muzaffarpur, Darbhanga and Bhagalpur. Only one district is found in the same category of low level of agricultural development and food accessibility. Five districts

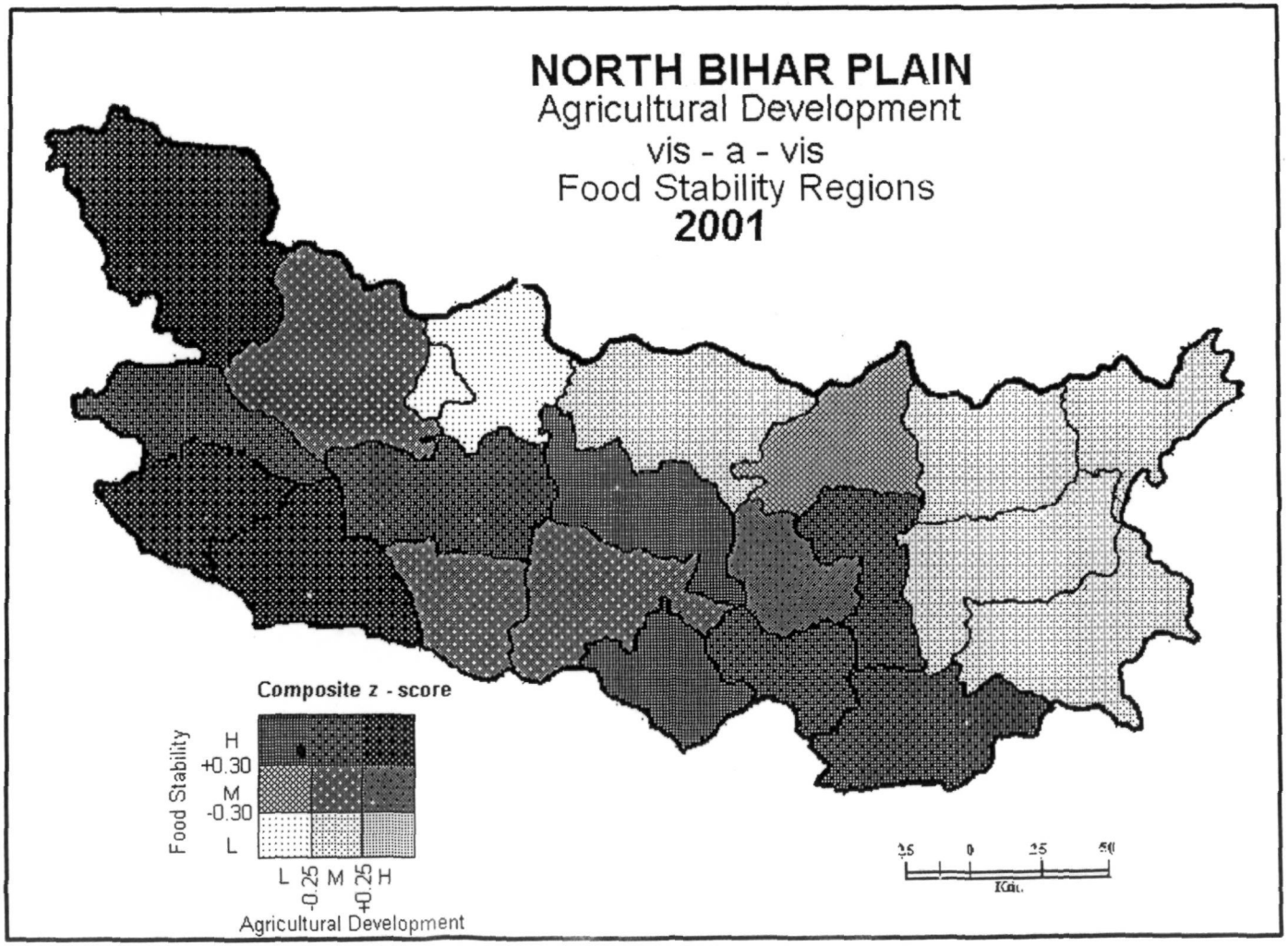

NORTH BIHAR PLAIN
Agricultural Development
vis - a - vis
Food Stability Regions
2001
Composite z - score
Food Stability
H
+0.30
M
-0.30
L
L
-0.25
M
+0.25
H
Agricultural Development
25
0
25
50
Km.

Fig.6.2

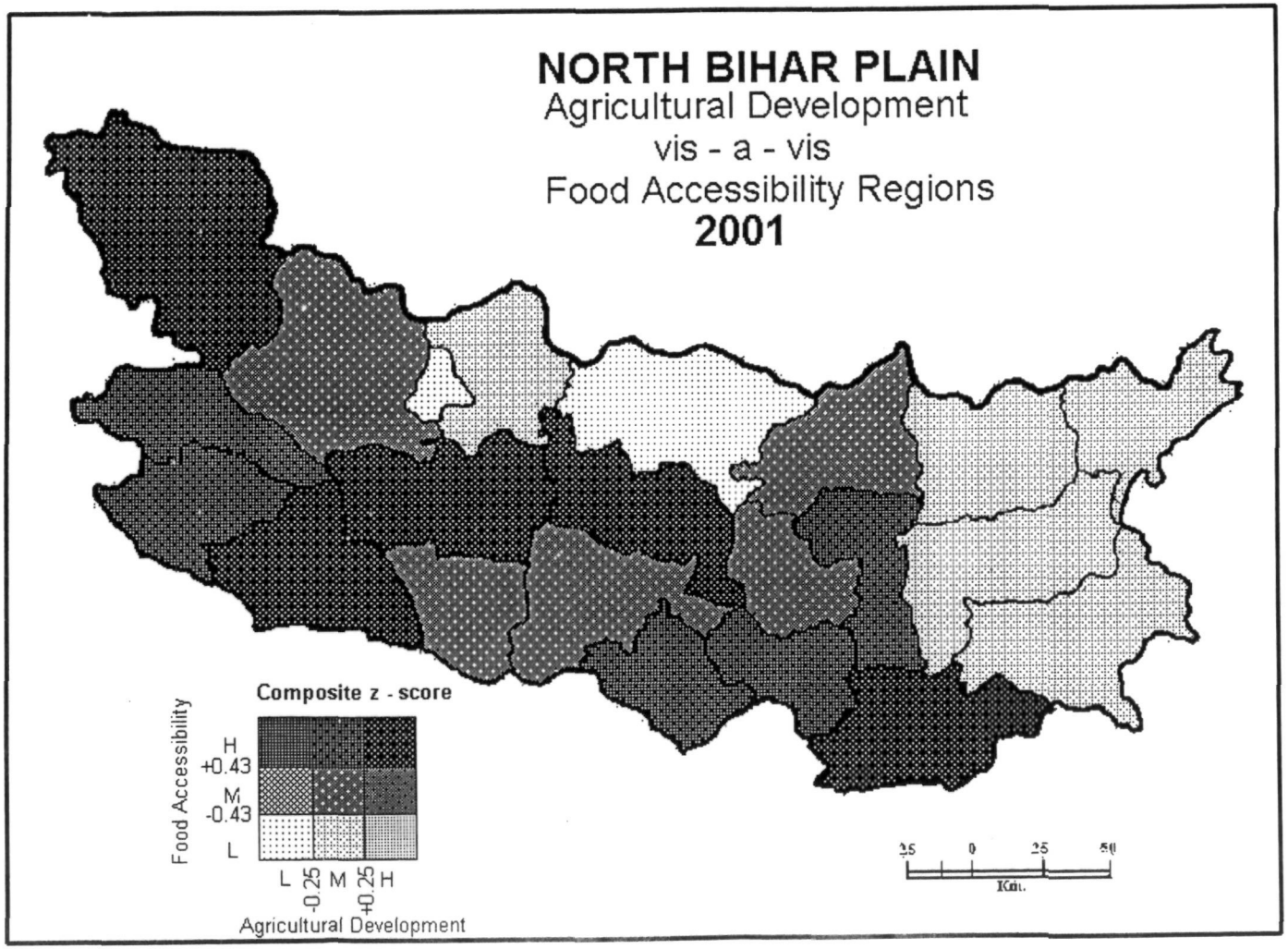

NORTH BIHAR PLAIN
Agricultural Development
vis - a - vis
Food Accessibility Regions
2001
Composite z - score
Food Accessibility
H
+0.43
M
-0.43
L
L
-0.25
M
+0.25
H
Agricultural Development
25
0
25
50
Km.

Fig.6.3

namely, Araria, Kishenganj, Purnia, Katihar and Sitamarhi are found in this category of medium level of agricultural development but low food accessibility.

Five districts record high level of agricultural development but moderate food accessibility which include Gopalganj, Siwan, Khagaria, Bhagalpur and Madhepura.

Agricultural Development and Food Security Regions

The overall food security consists of three basic components of food availability, food stability and food accessibility. Therefore, district-wise Z-score values of ten indicators of these components are calculated for food security and eleven indicators of agricultural development and composite Z-scores for each district were find out. The spatial distribution of agricultural development and food security is depicted in Fig.6.4. It may be noted that the range of variations in level of agricultural development is higher than that of food security level. The districts with reference to composite Z-scores are arranged into three categories of high (+0.25 and above), medium (+0.25 to –0.25) and low (-0.25 and below) level of food security, these categories in terms of values are found to be same for agricultural development out of these six districts namely, West Champaran, Gopalganj, Saran, Bhagalpur, Khagaria and Madheppura exhibit high levels of food security. Three districts of medium agricultural development such as East Champaran, Vaishali and Samastipur also record medium level of food security.

Three districts namely, Sheohar, Sitamarhi and Madhubani coincide in low level of agricultural development and food security. Thus, nearly 41.0 per cent of the districts correspond to the same category of agricultural development and food security and shows positive correlation between agricultural development and food security.

However, four districts namely, Araria, Kishenganj, Purnia and Katihar which are located in the extreme eastern part of the study region record medium level of agricultural development but exhibit low level of food

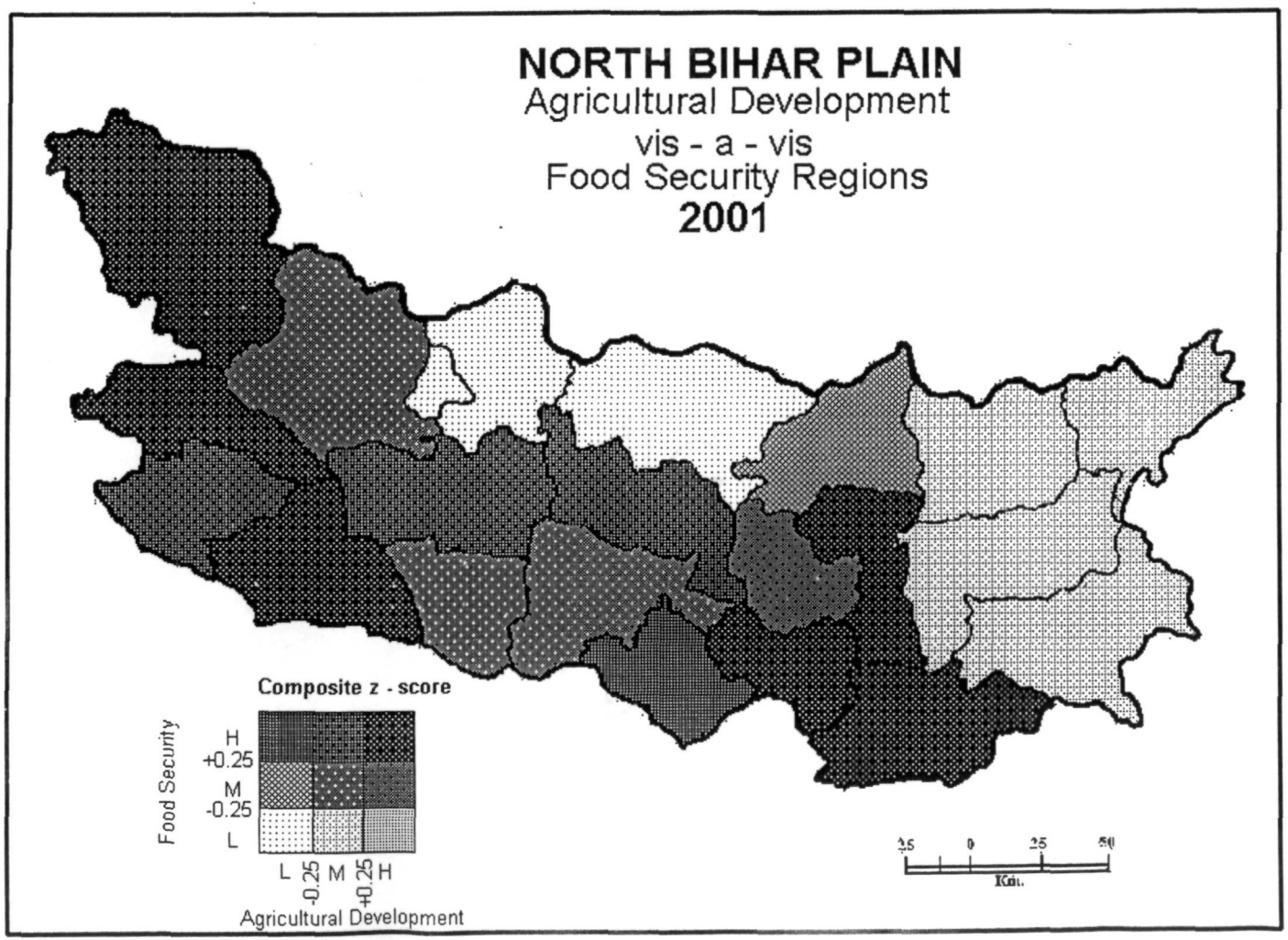

NORTH BIHAR PLAIN
Agricultural Development
vis - a - vis
Food Security Regions
2001
Composite z - score
Food Security
H
+0.25
M
-0.25
L
L
-0.25
M
+0.25
H
Agricultural Development
25
0
25
50
Km.

Fig.6.4

security. Only one district of Saharsa records high agricultural development but moderate food security and located in the eastern part of the study area.

IMPACT OF AGRICULTURAL DEVELOPMENT ON FOOD SECURITY

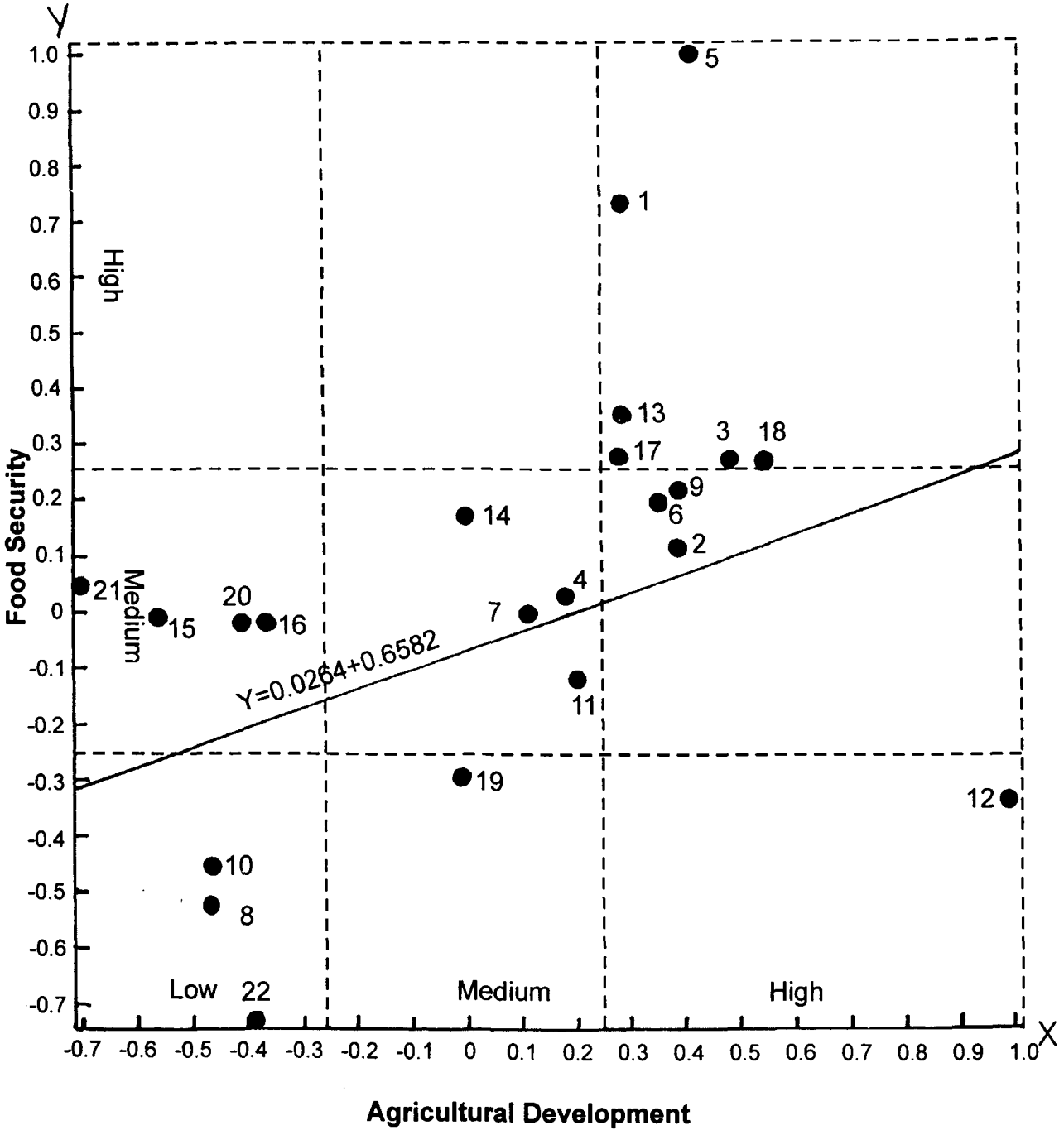
In order to analyze the impact of agricultural development on food security of the study area regression technique has been used. The study of a casual relationship is defined in terms of a mathematical form. These mathematical forms of the relationship are used in making predictions and also help us in assessing the relative influence of each of the independent variable on the dependent variable (Mahmood, 1998).[1] The regression line is scatter diagram shows relationship between agricultural development and food security in the districts of North Bihar Plain.

In the diagram, X axis represents the agricultural development and Y axis indicates the food security in the region. Regression line is drawn, with the help of $Y = a + bx$.

The results of regression line also shows that in general a positive correlation between agricultural development and food security has been observed with some exceptions. The regression line in scatter diagram as well as the coefficient of correlation shows that a positive correlation between agricultural development and food security exists in the study area. The value of coefficient of correlation (r) is 0.27 which is also an indication of positive correlation (Fig.6.5).

An analysis of levels of agricultural development and food security indicates that more or less each category of agricultural development corresponds to the same category of food security with some exceptions. Out of twenty two districts of the region, ten districts have shown high positive correlation between agriculture and food security.

DISTRICTS OF NORTH BIHAR PLAIN
(SCATTER DIAGRAM)
Relationship between Agricultural Development and Food Security (2001)



Note: Based on Table 6.1

r=0.27

Fig 6.5

RELATIONSHIP BETWEEN AGRICULTURAL DEVELOPMENT AND FOOD SECURITY

The multiple correlation coefficients of variables selected for the analysis of agricultural development from X_1 to X_{11} and food security from X_{12} to X_{21} based on 21 X 22 data matrix. Each of the variables once selected as dependent variable and the remaining as independent variables are tested with the assumption that the linear relationship exist in all the cases (Siddiqui, 1984, p.114).[2] In this regard, correlation coefficients between variables of agricultural development and variables of food security are tested at 1 per cent and 5 per cent significant level. Table 6.3 shows the inter-correlation among the variables. The relationship of dependent variable X_1 (productivity based on Yang's yield index) with fertilizers consumption (+0.522) and net irrigated area (+0.604) is highly positive and it is found significant at 5 per cent and 1 per cent level respectively.

X_2(net irrigated area by canal) has recorded significant degree of negative relationship (-0.597) with the variables X_5(net irrigated area by tube wells) but it has significant positive association with three variables of net irrigated area (+0.454), caloric availability (+0.679) and production of foodgrains (+.569). The former one variable is significant at 1 percent and latter two significant at 5 per cent level respectively.

Variable X_{10} (net irrigated area by tube wells) has significant negative correlation with variable net irrigated area by other sources (-0.586).

Variable X_4 (Net irrigated area by other sources) has significant of positive relationship with two variables of agricultural loans (+0.756) and road density (+0.767), which are significant at 1per cent level. Two variables of net irrigated area (+0.559) and production of foodgrains (+0.559) are positively correlated with HYV of seeds but it is negatively associated with X_7 (number of tractors).

The variable X_7 (Number of tractors) has a very strong positive correlation (+0.542) at 1 per cent significance level with variable X_{14} (yield of foodgrains). This variable X_7 has also moderate positive associated with

Table 6.2

Indicators Selected for the Measurement of Agricultural Development and Food Security in North Bihar Plain

Variables	Definition
X_1	Productivity based on Yang's crop yield index
X_2	Percentage of canal irrigation to the net irrigated area
X_3	Percentage of tube –well irrigation to the net irrigated area
X_4	Percentage of irrigated area by other sources to the net irrigated area
X_5	Percentage of area under High Yielding Varieties of seeds to the total cropped area
X_6	Consumption of fertilizers (in kg per ha.)
X_7	Number of tractors per 10,000 ha. of total cropped area
X_8	Number of pump sets for irrigation per 10,000 ha. of cropped area
X_9	Percentage of net sown area to the total cropped area
X10	Percentage of net irrigated area to the total cropped area
X_{11}	Agricultural loans in Rs. per 1000 hectare of total cropped area
X_{12}	Caloric availability per head per day
X_{13}	Production of foodgrains in kg per head per annum
X_{14}	Yield of foodgrains (in kg per hectare)
X_{15}	Storage capacities per 1000 population (in quintals)
X_{16}	No. of fair price shops per 1000 population
X_{17}	Percentage of families above poverty line
X_{18}	Percentage of literacy
X_{19}	Percentage of main workers to the total population
X_{20}	Road density /kms^2
X_{21}	Urbanization

Table 6.3 Results of Correlation (r) Between Variables of Agricultural Development and Food Security in North Bihar Plain 2001

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}	X_{20}	X_{21}
X_1	1.000																				
X_2	0.203	1.000																			
X_3	-0.043	-0.597**	1.000																		
X_4	-0.135	-0.296	-0.586**	1.000																	
X_5	0.310	0.233	-0.199	-0.007	1.000																
X_6	0.522*	-0.235	0.018	0.198	0.320	1.000															
X_7	0.195	0.402	-0.243	-0.176	-0.514*	0.299	1.000														
X_8	0.117	-0.350	0.319	-0.019	0.198	0.097	-0.061	1.000													
X_9	0.417	0.326	-0.285	0.015	0.230	0.036	0.204	-0.025	1.000												
X_{10}	0.604**	0.454*	-0.164	-0.233	0.559**	0.270	0.295	0.294	0.447*	1.000											
X_{11}	0.124	-0.244	-0.426*	0.756**	0.052	0.328	0.019	0.090	0.104	-0.050	1.000										
X_{12}	0.158	0.679**	-0.297	-0.352	0.341	-0.064	0.452*	-0.376	0.015	0.219	-0.379	1.000									
X_{13}	0.275	0.569**	-0.262	-0.259	0.434*	-0.030	0.354	-0.274	0.017	0.328	-0.244	0.726**	1.000								
X_{14}	0.277	0.386	-0.284	-0.095	0.382	0.053	0.542**	0.047	0.127	0.221	-0.210	0.557	0.223	1.000							
X_{15}	0.131	0.023	0.148	-0.211	-0.108	0.175	-0.031	-0.120	-0.290	-0.060	-0.110	0.134	0.089	-0.107	1.000						
X_{16}	0.034	-0.053	0.053	-0.030	0.113	0.091	0.233	0.604**	0.170	0.147	-0.153	-0.037	-0.102	0.208	0.006	1.000					
X_{17}	0.332	0.109	0.086	-0.232	0.330	0.080	0.468*	0.537**	-0.042	0.367	-0.040	0.173	0.118	0.514*	-0.185	0.395	1.000				
X_{18}	0.260	-0.098	-0.040	0.147	0.291	0.299	0.149	0.684**	0.247	0.480*	0.129	-0.344	-0.137	-0.047**	-0.020	0.610**	0.225	1.000			
X_{19}	-0.086	0.383	-0.153	-0.199	-0.379	-0.152	-0.208	-0.733**	-0.179	-0.260	-0.176	0.393	0.268	-0.102	0.263	0.682**	-0.439*	-772**	1.000		
X_{20}	0.041	-0.172	-0.491	0.767**	0.020	0.171	-0..031	0.046	0.073	-0.144	0.949**	-0.337	-0.204	-0.191	0.005	-0.088	-0.071	0.095	-0.134	1.000	
X_{21}	0.146	-0.051	-0.127	0.172	0.259	0.247	0.388	0.124	-0.056	-0.102	0.158	0.077	0.268	0.112	0.460*	0.428*	0.150	0.302	-0.291	0.288	1.000

* Significance at 5 per cent level

** Significance at 1 per cent level

variables X_{12} caloric availability (+0.452) and X_{17} families above poverty line (+0.468) both significant at 5 per cent level.

X_8 (number of pumpsets) is inversely and significantly correlated with main workers (-0.733) and positively associated with variables number of fair price shops (+0.604), families above poverty line (+0.537) and literacy rate (+0.684). They all are significant at 1per cent level. Variable X_9 (net sown area) has recorded a moderate degree of relationship (+0.447) with net irrigated area (+0.447) and it is significant at 5 per cent level.

Variable X_{10} (net irrigated area) is positively related with literacy rate (+0.480) and it is significant at 5 per cent level. Variable X_{11} (agricultural loans) is positively and significantly correlated with road density (+0.949) and it is significant at 1 percent level.

The results of linear correlation between X_{12} (caloric availability) and the other independent variables such as X_{13} (production of food grains) and X_{14} (yield of food grains) have significant degree of relationship at 1 per cent level with a positive correlation coefficient of +0.726 and +0.557 respectively.

Variable X_{14} (yield of foodgrains) has recorded significant degree of positive relationship with the variable of families above poverty line (+0.514).

Variable X_{15} (storage capacity) has positive association with urbanization (+0.460), which is significant at 5 per cent level.

Taking variable X_{16} (number of fair price shops) as dependent variable and remaining variables as independent as shown in Table 6.3. It was observed that the relationship between fair price shops is strongly positive with literacy rate (+0.610) and main workers (+0.682), significant at 1 per cent level and urbanization (+0.428) at 5 per cent level whereas X_{19} (main workers) have negative relationship. There is strong negative correlation between X_{17}(percentages of families above poverty line) and main workers (-0.439) it is significant at 5 per cent level. A significant negative relationship has been found between X_{18} (literacy rate) and main workers (-0.772) at 1 per cent level.

REFERENCES

1. Mahmood, A. (1998): Statistical Method in Geographical Studies, Rajesh Publication, New Delhi, p.51.

2. Siddiqui, F.A. (1984): Regional Analysis of Population Structure, A Study of Uttar Pradesh, Concept Publishing Company, New Delhi, p.114.

CONCLUSION AND SUGGESTIONS

It may be concluded from the foregoing analysis that there are marked regional variations in the levels of agricultural development its determinants and food security in the North Bihar Plain. The levels of overall agricultural development measured in terms of a large number of input and output indicators is either high or medium in the western and southern parts of the study area, whereas, its eastern and northern parts is very backward in this regard. This pattern is also in close conformity with distributional pattern of the factors of agricultural development.

Further this study concludes that the yield of cereals in the North Bihar Plain is 16.35 quintals per hectare which is remarkably lower than the national average yield of 18.44 quintals per hectare. This lower yield of cereals in the study area is explained by lower percentage of net irrigated area to the total cropped area (19.33%), low concentration of tractors (32.63 per 10,000 hectares of total cropped area) and pumpsets (3115 per 10,000 hectares of total cropped area) as against their respective value of 43.02, 247.1 and 1599 at national level. Though, consumption of fertilizer in kg. per hectare (118.84) and percentage of area under High Yielding Varieties of seeds are 94.25, which are higher than the national average of 94.80 and 61.19 per cent respectively, still yield or productivity of agriculture in the study area is lower as compared to the national average on account of lower percentage of area under assured irrigation as it is the most important factors of agricultural development on which success of other inputs of agriculture depends.

The preceding discussion on food security in chapter V^{th} also reveals that caloric availability of the study area is far below 1944 calories per person per day than the national average of 2365 in 2001. It means that the study area has not been able to fulfill the total requirement of caloric intake of its people even at national standard level i.e., 2400 calories per person per day. The distributional pattern of caloric availability during 2001 among the districts of North Bihar Plain is not uniform as it varies from 1394 calories per head per day in Madhubani district to 3200 calories in West Champaran. Six districts namely, Saran, Vaishali, Sitamarhi, Sheohar, Madhubani and Bhagalpur have reported caloric availability even less than 1800 calories and most of

them are located in central north and southern part with exception of only one district namely, Bhagalpur in the south eastern part of the study area and rest of the districts either record high or medium caloric availability.

The position of foodgrains availability which is an important indicator of food security has also not been reported satisfactory during 2001. It has been estimated that 8.43 million tones of foodgrains have been required to meet minimum requirement of the existing population but actual production is 7.08 million tones. Thus, there is shortage of food up to the tune of 1.35 million tones. The regional average in respect of the availability of food has been worked out to 131 kg. per head per annum and the national average being 173 kg. as against a minimum requirement of 176 kg. This clearly implies an overall deficit in the supply of foodgrains to the extent of 45 kg. per capita per annum in the case of North Bihar Plain .

The regional pattern of food availability is depicted in Fig.5.3 which clearly shows that food deficit districts are mostly confined in the central part of the study area. The position in this regard is better in western and eastern part of the study area which either record high or moderate foodgrains availability. By and large similar pattern in the case of food stability and accessibility have also been observed. The overall situation of food security is better in the western and south eastern part of the study region, whereas it is worst in north central districts except only one isolated district in south central part.

As far as relationship between food security and agricultural development is concerned, it is found to be moderately positive in the case of roughly 41 per cent of the districts. Out of twenty two districts in the study area only nine districts have shown positive relation and coincide in the same category of both agricultural development as well as food security. The results of linear correlation also support this fact as there is a strong positive correlation between caloric availability and production of foodgrains (+0.726) and yield of foodgrains (+0.557).These are significant at 1 per cent level.

Following strategies are suggested to overcome the problems of food insecurity in the study area:

- ★ Since the yield of food crops in the region is lower than the national average due to lack of irrigation facilities, therefore it suggested that area under assured irrigation should be extended. It will help taking full advantage of Green Revolution for raising agricultural productivity and ultimately reducing food deficit of the region. Thus the shortage of 1.35 million tones of foodgrains annually in the region may be covered largely by increasing agricultural productivity which is possible through extension of bringing more and more areas under assured irrigation for the success of Green Revolution.
- ★ One of the major problems of this region is flood which badly damages the crops as well as life and the property of the people almost each and every year. In 2001 annual floods affected 8.2 million people and 7, 80,000 hectares of land out of which over half of the land were under crops. The estimated amount is Rs.28 billions loss to public property. Hence flood control measures should be taken on priority basis.
- ★ Though food insecure regions and states have been identified still identification of chronic and transitory food insecurity at household and individual level has not been attempted. So identifying vulnerable section especially weaker sections of society such as scheduled castes, scheduled tribes, backward castes minorities and women is the need of hour.
- ★ Food security depends not only on availability of adequate food supply but also on purchasing power of the people. Purchasing power of the people can be enhanced through generation of employment under various integrated rural development programmes covering the areas of flood control, providing irrigation facilities, construction of roads, development of agro- based industries and conservation of natural resources.
- ★ Public Distribution System (PDS) is one of the most important instruments to achieve food security. It plays a vital role in price stability of essential commodities such as cereals, edible oils and sugar. These commodities are sold

in the fair price shops at subsidized rate. However, the inclusion of poor in the PDS is quite low, leakages are high and there are innumerable problems in physical access. Low purchasing power is also a factor in the functioning of PDS. Hence there is need of proper functioning of PDS under the supervision of local self bodies and NGOS.

- ★ There are post harvest losses of nearly 10 to 15 per cent of foodgrains which can be minimized by providing proper storage facilities. Therefore, there is need to develop adequate storage facilities at Village Panchayat and Mandi levels managed by cooperative societies.
- ★ The study area experiences very high growth rate of population (2.8 per cent in 2001) as compared to 1.93 per cent in India. Therefore, high growth rate of population must be checked, which is possible by raising level of education and standard of living of people in the region.
- ★ This region also is one of the mostly densely populated regions of India where density of population is 1005 persons per square km. as against the national average of 324 persons per square km. which has led to fragmentation of land holdings. The average size of holding in North Bihar Plain is declining having fallen to around 0.073 hectare. This has slow down the modernization and development of agriculture.
- ★ This region faces serious problem of unemployment as the percentage of main workers to the total population is 25.34 per cent which has caused large scale out migration of the people especially of landless labour, marginal farmers in search of jobs to other states. Therefore, there is urgent need of creating job opportunities within the region by developing growth poles and growth centers.
- ★ Production of higher value crops should be encouraged along with technological support, inputs supply and marketing of their produce .NGOS can play vital role in this regard.

BIBLIOGRAPHY

Books

Acharaya, K.C.S. (1983): Food Security System of India, Concept Publication, New Delhi.

Agarwal, A. (1953): Indian Agriculture and its Problem, Ranjit Printers and Publisher, Delhi.

Ahmad,E.(1965):A Physical Economic and Regional Geography of Bihar, Ranchi

Ahmad,E.(1995): Physical Economic and Regional Geography, Ranchi

Alvi, Z. (1995): Statistical Geography, Method and Application. Rawat Publication, Jaipur, New Delhi.

Anderson, J.R. (1970): A Geography of Agriculture, Lowa.

Arora, R.C. (1976): Development of Agriculture and Allied Sectors, New Delhi.

Aykroyd,W.R.(0riginal edition), Gopalan, C. (6^{th} revised edition ,1966): The Nutritive Value of Indian Foods and the Planning of Satisfactory Diets, Indian Council of Medical Research, New Delhi.

Bhalla, G.S. and Alagh, Y.K. (1979): Performance of Indian Agriculture: A District-wise study, Sterling Publishing Company, New Delhi.

Blandford, H.F.(1989): Climates and Weather of India, London

Bansal, P.C. (1975): Agricultaral Problems of India, Vikas Publication, New Delhi.

Batra, M.M. (1978): Agricultural Production, Prices and Technology, Allied Publishers, Delhi.

Bhalla, G.S. and Singh, G. (2001): Indian Agriculture: Four Decades of Development, Sage Publication, New Delhi.

Bigman, D. (1982): Coping with Hunger: Towards a System of Food Security and Price Stabilization. Cambridge, Massachusetts.

Bridger, G. and Sessions, M. (1970): Famine in Retreat, The English Language Book Society and J.M. Dent and Sons Ltd., London.

Burns, W. (1944): Technological Possibilities of Agricultural Development in India, Govt. Printing, Labour.

Butani, D. (1993): Dictionary of Agriculture, West Vill Publishing. House, New Delhi.

Carter, H. (1981): *Food Security in a Hungry World:* Conference Proceedings, Davis, California, University of California Press.

Chamber's (1972): Twentieth Century, Dictionary, Allied Publishers, Pvt. Ltd. New Delhi.

Chaturvedi R. (1997): Food Secruity and Panchayati Raj in India, Concept Publication, New Delhi.

Chaturvedi,P.(2002): Food Security In South Asia, Concept Publication, New Delhi.

Chaudhari, P. (1972): Readings in Indian Agricultural Development, Georg and Allen & Urwin, London.

Chopra, R.N. (1988): Food Policy in India, Intellectual Publishing House, New Delhi.

Clay, E. J & Longhurst, R. (1981): Food Security, Food Imports and Food Aid in East and Southern Africa., Institute of Development Studies, Sussex.

Dantwala, M.L.et.al. (1986): Indian Agricultural Development: Since Independence, Oxford & IPH Publishing Company, Pvt. Ltd. New Delhi.

Dasgupta, B. (1980): The New Agrarian Technology in India, Delhi.

Dayal, R. (1968): India's New Food Strategy, Metropolitan Book Co. Pvt. Ltd. New Delhi.

Desai, Bhupat, M. (1992): Institutional Finance for Agricultural Development: An Analytical Survey of Critical Issue, Oxford IBH Publishing Company, New Delhi.

Dev,S.M.,Kanan, and Ramachandran (2003): Towards A Food Secure India,Published by Institute for Human Developments, New Delhi.

Dhawan, B.D. (1987): Irrigation in India's Agricultural Development, Sage Publication, New Delhi.

Dreze, J and Sen, A. (1993): Hunger and Public Action, Oxford University Press, Paris.

Drinie,S.(2003):Food Security in Southern Africa: Causes and Responses from Across the Region, Workshop Report, Human Science Research Council, Pretoria.

Etinne, G. (1988): Food and Poverty, Sage Publications, New Delhi.

Fienup, D.P. and et. al. (1969): The Agricultural Development of Argentina, New Delhi.

Gangulee, N. (ed): Health and Nutrition in India, Faber and Feber Ltd. London.

Ghosh, B.N. (1978): Studies in Population and Economic Development, Deep & Deep Publication, New Delhi.

Gopalan, C., et.al. (1969): Diet Atlas of India, National Institute of Nutrition, ICMR, Hyderabad.

Harris, B. (1991): Child Nutrition and Poverty in South India, Concept Publication, New Delhi.

Hussain, M. (1979): Agricultural Geography, Delhi.

Jaiswal, P.L. (1971): Proceedings of the Symposium on Science and Indian Food Problem, ICAR, New Delhi.

John Boyd Orr (1953): The White Man's Dilemma: Food and the Future, George Allen and Unwin Ltd. London

King,T.(1953): Water, Miracle of Nature, New York

Kishan,G.(1992): *The Concept of Agricultural Development* in Mohammad, N.(ed): Dynamics of Agricultural Development ,Concept Publication, , No.4, Vol.7. New Delhi.

Korishettar, S.F. (1992): *Agricultural Growth and Rural Poverty,* In Mohammad N. (ed): New Dimensions in Agricultural Geography, Vol. 4, New Delhi.

Krishna, G. (1981): *The Concept of Agricultural Development* in Noor Mohammad (ed.): Perspective in Agricultural Geography, Concept Publishing Company, Vol.4, New Delhi.

Krishna, R. (2000): New Challenges Facing Indian Agriculture, Vishal Andhra Publication House, Hyderabad.

Krishnanji, N. and Krishnan, T.N. (eds) (2000): Public Support for Food Security: The Public Distribution of India, Sage Publication, New Delhi.

Krishnan,M.S.(1960):An Introduction to the Geology of India, Madras.

Krishna, M.S. (1956): Geology of India and Burma, Madras.

Kumar, A. and Jha,d.(2003):Agricultural Development in Bihar, Institute of Human Development, New Delhi.

Lee, Christina (1998): Women Health, Psychological and Social Perspective, Sage Publication, New Delhi.

Marks, H. (1970): Nutrition and Elementary Food Science, Frederick Warne and Co. Ltd., London.

Martin, E.A. (1965): Nutrition in Action, Oxford and IBH Publishing Co. New Delhi.

Mahmood, A. (1977): Statistical Methods in Geographical Studies, Rajesh Publication, New Delhi.

Memoria, C.B. (1993): Agricultural Problems of India, Kitab Mahal, Allahabad.

Misra, R.P. (1988): Community Storage of Foodgrains, Harman Publishing House, New Delhi.

Mitra, A and Mukherji, S. (1980): Population Food and Land Inequality in India 1971, A Geography of Hunger and Insecurity, New Delhi.

Mitra, A. (1978): India's Population: Aspects of Quantity and Control, Abhinav Publication, New Delhi.

Mohammad, A. (1978): Situation of Food and Nutrition in Rural India, Concept Publication, New Delhi.

Mohammad, A. (1979): Dynamics of Agricultural Development in India, Concept Publishing Company, New Delhi.

Mohammad, A. (1981): *Regional Imbalances in Lands of Agricultural Productivity* in Noor Mohammad (ed.) Perspective in Agricultural Geography, Concept Publishing Company, New Delhi.

Mohammad, A. (1986): Food and Nutrition in India, Rajesh Publications, New Delhi.

Mohammad, A. (1989): Food Production and Food Problem in India, Concept Publication, New Delhi.

Mohammad, N. (ed.) (1981): Perspective in Agricultural Geography, Concept Publishing Company, New Delhi.

Mohammad, N. (ed.) (1992): New Dimension in Agricultural Geography, Concept Publishing Company, New Delhi.

Morris, D. (1978), Food Production Systems, National Priorities, The Open University Press, Walton Hall, Milton Keynes, MK7 6AA.

Mukherjee, R. (1938), Food Planning for Hundred Millions, Macmillan & Company Limited, London.

Munir, A. (1992): Agricultural Productivity and Regional Development, Manak Publication, Delhi.

Nair, K.N.S. (1980): Technological change in Agriculture, New Delhi.

Naliji, G. (1986): Regional Perspective in Agricultural Development, Concept Publication, New Delhi.

Nath, M. (2003): Rural Women Workforce in India, B.R. Publication, New Delhi.

Paccy, A. and Payme (1985): Agricultural Development and Nutrition, FAO and UNICEF.

Pandey, M.S. (1963): The Historical Geography and Topography of Bihar, Patna.

Pandit, A.D. (1965): Application of Productivity, Concept to Indian Agriculture, Productivity, Special Issue on Agricultural Productivity, (2-3).

Parikh, K.S. and Radhakrishna, R. (eds) (2002): India Development Report, Oxford University Press.

Patil, J. (1996): Agricultural and Rural Reconstruction, Concept Publication, New Delhi.

Roday, S. (2003): Food Hygiene and Sanitation in Food Industry, Tata McGraw Hill, New Delhi.

Ross, D.N. (1977): Feeding the World, Encyclopedia of Food Agriculture and Nutrition, McGraw Hill.

Schuh, G.E. and McCoy, J.L. (1986): Food, Agriculture and Development in the Pacific Basic, Westview Press, London.

Shafi, M. (1984): Agricultural Productivity and Regional Imbalances: A Study of Uttar Pradesh, Concept Publishing Company, New Delhi.

Shafi, M. (2000): Agricultural Geography of South Asia, MacMillan Company of India Limited, New Delhi.

Shafi, M. and Aziz (eds) (1989): Food System of the World, Rawat Publication, Jaipur.

Shafiqullah, (2000): Work Participation and Development, Mohit Publication, Company, New Delhi.

Sharma, T.C. (2003): India an Economic and Commercial Geography, Vikas Publication, New Delhi.

Sharma, P.S. (1971): *Agricultural Regionalization of India* in Chandra Shekhar (ed.): Economic of Socio-Cultural Dimensions of Regionalization, General, New Delhi.

Shiva,V. and Bedi,G.(2002):Sustainable Agriculture and Food Security, The Impact of Globalisation, Sage Publications, New Delhi.

Singh, J. (1974): An Agricultural Atlas of India, Kurukshetra.

Singh, J. (1976): An Agricultural Geography of Harayana, Vishal Publication, Haryana.

Singh, J. (2002): Agricultural Geography, Tata McGraw Hill, New Delhi.

Singh, J. and Dhillon, S.S. (1994): Agricultural Geography, New Delhi.

Sinha, R.P. (1961): Food in India, Oxford University Press.

Smith, D.M. (1973): The Geography of Social Well Being in the United States, Amol Heinemann, New York.

Spate, O.H.K. (1954): India and Pakistan: A General and Regional Geography, London.

Stamp, D. (1951): Discovering Geography: Our Food, Longman Green and Co. Ltd., 6 & 7 Clifford Street, London.

Stamp, L.D. (1962): The Land of Britain, Its Use and Misuse, London.

Sukhatme, P.V. (1965): Feeding India's Growing Millions, Asia Publishing House, New Delhi.

Swaminathan, M.S. (1981): Building a National Food Security System, Indian Environmental Society, New Delhi.

Symons, L. (1968): Agricultural Geography, London.

The Educational Planning Group (1983): Food and Nutrition, Arya Publishing House, New Delhi.

Walpole, P. (1978): Food Production System; Crops and their Environment, The Open University Press, Walton Hall, Milton Keynes, MK7, 6AA.

Williams, T. Moon, A. and Williams, M. (1990): Food Environment and Health, WHO, Geneva.

Wadia, D.N. (1939): Geology of India

Journals

Ahmed, E., (1946-47): Hwangho of Bihar, *Aligarh Magazine,* Aligarh Muslim University, p.105.

Banerjee, B. (1997): Population Explosion, Food Security and Sustainable Development, *Geographical Review of India,* Vol. 59, No.1, pp. 1-10.

Bhagat, R.B. (2000): Population Growth Poverty and Foodgrains Supply in India: The Present Trend and Future Prospects, *Asian Profile,* Vol. 23, No. pp. 309-18.

Bhasker, B.P., Challa, O. and Reddy, R.S. (1997): Spatial Variations in Determinants of Agricultural Efficiency in Andhra Pradesh, *Geographical Review of India*, Vol. 59, No.1, pp. 54-61.

Burrard, S. G. (1912): On the Origin of Himalayan Mountains, Professional paper No. 12, *Geological Survey of India,* Calcutta, p.11.

Cannon, T. (2002): Food Security Food Systems and Livelihoods: Compting Explanations of Hunger, *DIE ERDE* ,Vol. 133, pp. 345-368

Clover, J., (2003): Food Security in Sub-Saharan Africa, African Security Review, Vol.12, No.1 pp.5-15.

Chakravarty, A.K. (1970): Food Sufficiency Pattern in India, *Geographical Review*, Vol. 110, New York.

Champa, M.(1976): Agricultural Development and the Role of Fertilizers, *Indian Journal of Regional Science*, Vol. 8, N. 1 and 2, pp. 151.

Crosson, P.R. and Rosenberg, N.J. (1989): Strategies for Agriculture, *Scientific American*, Vol. 261, No. 3, pp.78-85.

Dey, S.M. (1996): Food Security: PDS vs. EGS A Tale of Two States, *Economic and Political Weekly*, Vol. 31, No. 27, pp. 1752-64.

Diwakar, G.D. (2001): Sustainable Food Security in different Agro-Climatic Zones of India through arrival of NARP concept for Agricultural Research, *Indian Farming*, Vol. 50, No. 10, pp.39-42.

Dua, R. and Mohammad, N. (1998): Spatial variations in the levels of agricultural development in Harayana, *The Geographer*, Vol. 45, No.1, pp.16-31.

Dunn, J. A. (1941): Memories of the Geological Survey of India, (The economical, geology and mineral resources of Bihar Province), Vol. 78, (Calcutta, 1942), p.8.

Ghosh, G.N. (2000): Food Insecurity, The Greatest Challenge of the Millennium, *Indian Farming,* Vol. 50, No. 7, pp. 7-9.

Gopalan, C. (1995): Towards Food and National Security, *Economic and Political Weekly,* Vol. 30, No. 1, pp. 23-28.

Grigg, D. (1999), The Changing Geography of World Food Consumption in the Second Half of the Twentieth Century, *The Geographical Journal*, Vol. 165, part I, pp. 1-11.

Hanafi, et al. (1999): Declining Trend of Foodgrains Availability and Food Security in U.P. *The Geographer,* Vol. 46, No. 2, pp. 137-54.

Hashim, S.R. (1997): Food Security and Poverty, *Journal of the Indian Society of Agricultural Statistics,* Vol. 1, No. 3, pp. 240-50.

Hedge, N.G. (2000): Challenges of Food Insecurity- Call for a Paradigm Shift, *Indian Farming,* Vol. 50, No. 7, pp. 18-21.

Hedge, N.G. (2001): Food and Environment Securities-Rural Poor Should be the Key Players, *India Farming,* Vol. 50, No. 10, pp. 20-23.

Kaur, P. and Sethi, K. (1995) Inter-district Variations in Agricultural Productivity in Punjab, *Indian Journal of Regional Science*, Vol. 27, No.1&2, pp.145-156.

Kravdal, O. (2001): Has Population Growth Restricted Improvement in Food Availability per head, *Population Studies,* Britain, Vol. 55, No. 2, pp. 105-117.

Mathur, P.B. (2000): World Food Day- A Millennium Free from Hunger, *Indian Farming,* vol. 50, No. 7, pp. 15-17.

Mohammad, A. (1995): Problem of Food Availability and Security in the Middle East, *The Geographer*, Vol. 52, No.2, pp. 59-71.

Mohammad, N. (2003): Spatial Inequality in Food Security in Rural India, *The Geographer,* Vol. 50, No. 1. pp. 43-57.

Panth, A.S. (1997): Social Network and Food Security in Rural Karnataka, *Economic and Political Weekly*, Vol. 32, No., 15, pp. 756-58.

Pandey, M. S.(1961): The Rainy Season in Bihar, *Geographical Review of India*, 23, No. I.

Plucknett, D.L. and Winkelmann, D.L. (1995): Technology for Sustainable Agriculture, *Scientific American*, pp.182-186.

Radhakrishna, R. (1991): Food and Nutrition: Challenges for Policy, *Journal of the Indian Society of Agricultural Statistics,* Vol. 43, No. 3, pp. 211-27.

Saxon, E.A.(1964): Special Concepts of Productivity, Regional Variation in Agricultural Development and Productivity, *Indian Journal of Agricultural Economics,* Vol. 19, No. 1, p. 266.

Sarkar, A.N. (2001): National Food Security Perspectives with a Global Vision, *Indian Farming*, Vol. 50, No. 10 pp. 29-36.

Siddiqui, F.A. (1984): Regional Pattern of Occupational Combinations in Uttar Pradesh, *The Geographer,* Vol. 31, No. 1, 53-61.

Siddiqui, S.H. (1998): Regional Variation of Agricultural Development in North Bihar Plain, *Geographical Review of India*, Vol.49, No. 3, pp.49-54.

Siddiqui, S.H. (1988): Role of Modern Inputs on Agricultural Productivity in North Bihar Plain, *The Geographer*, Vol.36, No.2.

Siddiqui, S.H., Rehman, H. and Siddiqui, M.F. (1984): Regional Analysis of Agricultural Productivity in Bihar, *The Geographer*, Vol. 31, No. 1.

Singh, A.K. (2002): Water: The Source of Food Security, *Indian Farming*, Vol. 52, No.7, pp. 24-28.

Singh, T. (1998): Fertilizer Use, Food Security and Sustainable Agricultural Development, An Indian Experiences, *The Geographer*, Vol. 54, No. 2, pp. 78-92.

Singh, R. K. P. and Kumar, S. (2000): Agricultural Development in Bihar, Emerging issues, The Bihar Journal of Agricultural Marketing,7(1),57-62.

Singh,R.K.P.(2004):Agricultural Development in Bihar: Challenges and opportunities, *Agricultural Situation in India*,Vol.LXI,No.7,pp.467-473.

Srivastava, G.C. (1998): Sustainable Agricultural Development in Bihar: Potential and Constraints, *Agricultural Situation in India*, Vol.55, No.4, pp.197-208.

Suryanarayana, M.H. (1995): Growth Poverty and Levels of Livings, Hypothesis, Methods and Policies, *Journal of Indian School of Political Economy*, Vol. 7, No. 2, pp. 203-55.

Swaminathan, M.S. (2001): Science and Sustainable Food Security, *Indian Farming*, Vol. 50, No. 10, pp. 4-6.

Swaminathan, M.S. (2001): Sustainable Livelihoods and Freedom from Hunger, *Indian Farming*, Vol. 51, No. 8, pp. 6-9.

Tarrant, J.R. (1990): World Food Prospects for the 1990s' *Journal of Geography*, Vol. 89, No. 6, pp. 234-38.

Vyas, V.S. (2000): Ensuring Food Security, The State, Market and Civil Society, *Economic and Political Weekly.* Vol. 35, No. 50, pp. 1402-07.

Yang, W.Y. (1968): Methods for Farm Management Investigations for Improving Farm Productivity, *Agricultural Development, Paper No. 80,* FAO, Rome.

Miscellaneous

A Report to President Johnson (1967): *The World Food Problem,* The United States Information Service, New Delhi.

Agricultural Statistics- At a glance, Agricultural Statistics Division, Directorate of Economics and Statistics, Ministry of Agriculture, Govt. of India, New Delhi(various issues).

Asian Production Organization, (1997): *Marketing System of Agricultural Products, APO, Tokyo*

.Bihar Through Figures, Directorate of Statistics and Evaluation, Bihar, Patna(various issues).

Callear, D.L. & Blandford. C. (1981): *Food security and the International Wheat Agreement,* Cornell Agricultural Economics, Staff Paper, Department of Agricultural Economics, Cornell University.

FAO & WFP (1979): *Food Aid Requirements and Food Aid Targets in The Eighties in Collaboration with World Food Programme,* (WFP & CFA: 8/4-A), Rome.

FAO (1956): *Functions of a World Food Reserve- Scope and Limitations,* FAO Commodity Policy Studies No. 10, Rome.

FAO (1958): *National Food Reserve Policies in Underdeveloped Countries,* FAO Commodity Policy Studies No. 11, Rome.

FAO (1965): Nutrition in Relation to Agricultural Production, FAO of UN, Rome.

FAO (1966): Nutrition and Working Efficiency, FAO of United Nations, Rome.

FAO (1969): *Manual in Food and Nutrition Policy*, FAO of United Nations, Rome.

FAO (1973): *World Food Security:* Proposal of the Director General, (C 73/17) Rome.

FAO (1974): *The World Food Conference in 1974,* United Nation, Rome.

FAO (1980): *The State of Food and Agriculture 1979,* FAO /UN, Rome.

FAO (2000): *State of Food Insecurity in the World, United Nations.*

India (2003): *Indian Economic Survey 2000-01,* Ministry of Finance, New Delhi.

International Food Policy Research Institute (1978): *Food Security: An Insurance Approach,* Konadreas, P., Huddleston, B. and Ramangkura, V Research Report, No. 4. Washington D.C.

International Food Policy Research Institute (1981): *Food Security in the Sahel: Variable Import Levy, Grain Research, and Foreign Exchange Assistance. J. McIntire.* Research Report No. 26. Washington D.C.

International Monetary Fund (1981): *Compensatory Financing for Fluctuations in the Cost of Cereal Imports.* Louis Goreux, in Food Security for Developing Countries, Secretariat, Paper, No. 13, London.

Natarajan, D. (1975): *Inter-Casual Growth of Population,* Census Centenary Monograph, No. 3, Census of India 1971, New Delhi.

Overseas Development Council (1982): *A Food Security Approach for the 1980s.* Chapter III, U.S. Foreign Policy and the Third World: Agenda 1982. New York.

O'malley, L. S.(1917): *Bengal District Gazatteer: Sikkim*, Calcutta, p.49.

O'malley, L. S. S.(1911): *Bengal District Gazetteer: Purnia,* Calcutta, p.3.

Royal Commission on Agriculture in India, 1928, p.72.

Report of the Irrigation Commission, Ministry Of Irrigation And Power, New Delhi, 1972, Vol. III (Part I), p.131.

Rafiullah, S.M. and Siddiqui, F.A. (1997): *Regional Pattern of Vital Processes in Uttar Pradesh,* Unpublished Report of Major Research Project Sponsored by the UGC. Department of Geography, AMU. Aligarh.

The Hindu, (2002): *Global Warning a Threat to Food Security.* The Hindu, 9th October, New Delhi.

The Times of India, (1999): *Food For Through,* The Times of India, Hindu, 22nd October, New Delhi.

The Times of India, (2001): *Rotting Foodgrains Leave Little Space for Fresh Stock*, The Times of India, 7th September, New Delhi.

UN/FAO World Food Programme (1979). *Role of Food Aid Strengthening Food Security in Developing Countries* (WFP/CFA 8/4-B), Rome.

United Nations (1952): *Food and Famine: Procedures for International Action in the Even of Emergency Famines Arising from Natural Causes,* (ECOSOC E/2220).

United Nations (2000): United Nation Administrative Committee for Coordination: Sub-Committee on Nutrition (ACC: SCN) (2000), *Forth Report on World Nutrition Situation, Geneva.*

United Nations World Food Council (1976): International System of Food Security (WFC/22), Rome.

United Nations World Food Council (1979): *World Food Security for the 1980s:* Report by the Executive, Director (WFC/1979/5), Rome.

United Nations World Food Council (1982): *World Food Security and Market Stability:* a Developing Country Owned Reserve, (CFC/1982/5), Rome.

United States Department of Agriculture (1977): *The Relationship between Trade and World Food Security.* Dale Hathaway. Washington, D.C.

United States Department of Agriculture (1982): *World Food Aid Needs and Availabilities.*

World Bank (1980): *Food Security in Food deficit Countries: a Probabilistic Simulation of the Effect Policies.* S. Reutlinger & K. Knapp. Staff working paper no. 393, Washington, D.C.

World Bank (1999): *India-Foodgrains Marketing Policies: Performing.*